Power and The Engineer

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A HABIT often acquired by young engineers and one that should be discouraged from the start is that of continually running to the superintendent with every little trouble that is discovered.

Some do it under the delusion that their superiors will get the impression that they are alert and "onto their job." In such cases, the fallacy needs no comment.

More often, however, it is done through lack of confidence, not that they are incompetent, for they may know very well what to do—perhaps better than the superintendent—but they hate to assume responsibility.

Backbone is as essential to an engineer as water is to a fish. If he does not make use of it in little things it is bound to fail him in an emergency, and then the inevitable happens.

The engineer is supposed to be a specialist in his line, and is hired as such.

Hence he should accept the responsibilities attendant upon his position.

If unwilling to do this it is clearly evident that he has chosen the wrong vocation, and he should lose no time in changing over to some line more fitting to his temperament.

The superintendent has his own duties to perform with a thousand and one things to carry in his mind, and should not be bothered with minor operating details.

He may tolerate this for a short time, but it will soon become a nuisance and he will then look around for an engineer who will go quietly about his business and by his manner impress those about him with the confidence that he can successfully hold down the job and cope with all ordinary difficulties.

True, the superintendent may take more than a passing interest in the engine room, and may have a keen eye for details. When he comes around, let him find everything running smoothly and volunteer information only when asked.

Then show by your answers that you are thoroughly familiar with everything, but *do not talk too much* and make only such statements as you are prepared to back up.

This is one of the many rungs in the ladder to success.

It is applicable not only to the engineer, but to the oiler, fireman and other members of the operating force, as well, in their relations with their superiors.

Cooling the Condensing Water

By Warren O. Rogers

In a plant in Chattanooga spray nozzles and a cooling tower of 5000 gallons capacity per minute are used for this purpose. Johnstown, Penn., also has an interesting installation of spray nozzles.

An uptodate system of cooling condensing water by means of both spray nozzles and cooling tower, is in operation at the power plant of the Chattanooga Power and Light Company, Chattanooga, Tenn. In order that the reader may have a comprehensive idea as to the amount of condensing water used, it will not be amiss to make mention of the main steam units in the plant.

Arranged along one side of the turbine room, Fig. 1, are four 500-kilowatt and two 1000-kilowatt Curtis turbines, 2300-volt, 120-ampere, three-phase, 60-cycle units. The electric generators are all of the same make and output. There is also one 26 and 52 by 48-inch Hamilton-Corliss engine, direct connected to a General Electric direct-current generator of 1000 kilowatts capacity. Two 75-kilowatt Curtis turbines of the horizontal type run at a speed of 2400 revolutions per minute, noncondensing, and are direct connected to General Electric direct-current generators of 75-kilowatts capacity. In addition there is a steam-driven exciter unit, with an engine of the marine type driving a General Electric direct-current generator at a speed of 450 revolutions per minute. In the basement below the condensers are placed the dry-vacuum and motor-driven centrifugal pumps. The large turbines exhaust into Wheeler condensers and the four small units into Worthington condensers.

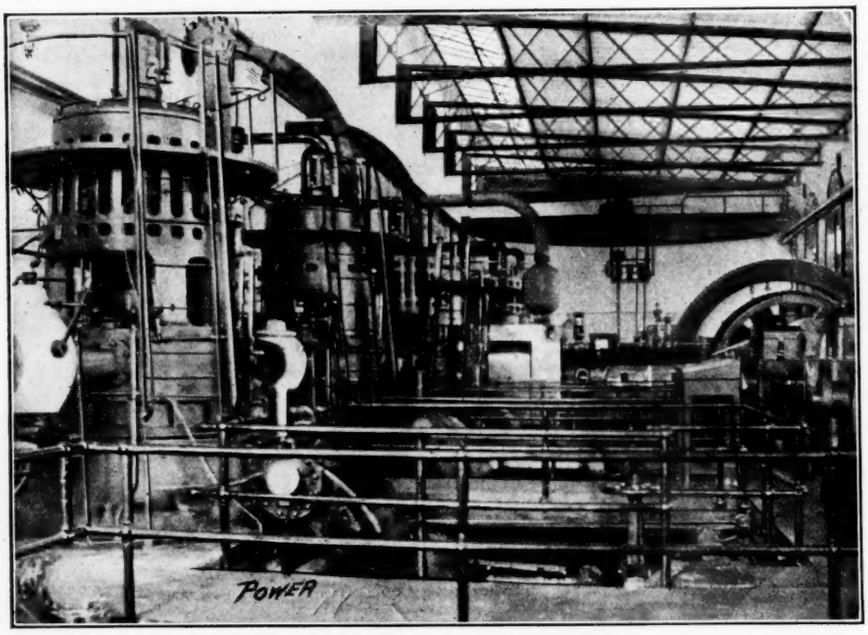


FIG. 1. SHOWING STEAM UNITS WHICH ARE RUN CONDENSING

The auxiliaries all run noncondensing, the steam being delivered to the feed-water heater.

Water for condensing purposes is taken from a pond 100 feet wide by 150 feet long, having an average depth of 4 feet, with the exception that at the intake point it has a depth of 10 feet. At the present time the condensers are furnished with circulating water by means of two steam-driven and one motor-driven centrifugal pumps of 3500 gallons capacity per minute, and one motor-driven centrifugal pump of 4500 gallons capacity per minute. It is the intention of the present chief engineer to substitute the smaller motor-driven unit with a second one of 4500 gallons capacity per minute.

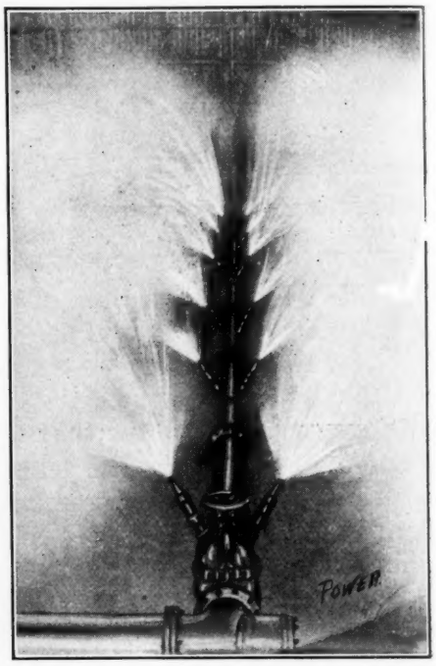


FIG. 3. ARRANGEMENT OF SPRAY NOZZLES

As the water is forced through the surface condensers it passes to the spray jet nozzles, Figs. 2 and 3, at a pressure of 18 pounds per square inch, and at a temperature of from 125 to 140 degrees,

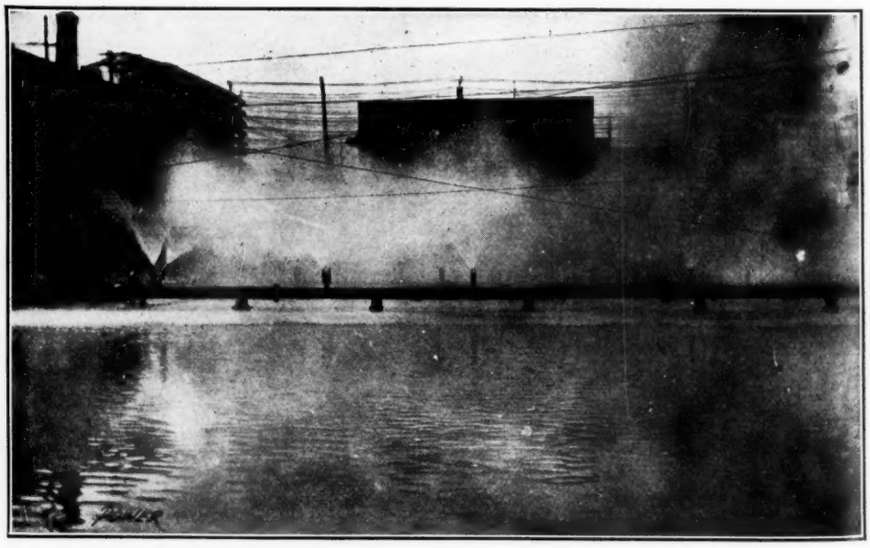


FIG. 2. SPRAY NOZZLES, COOLING TOWER AND POND

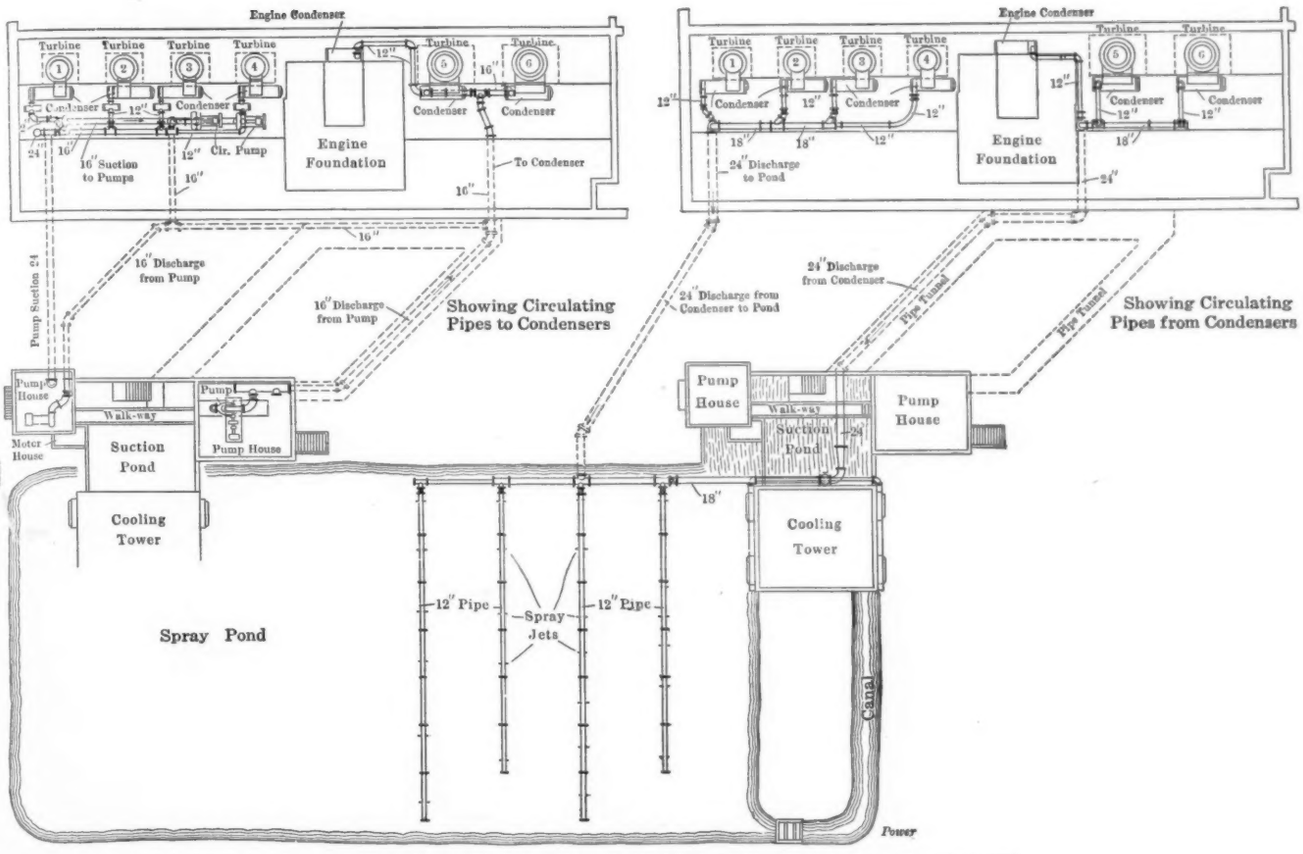


FIG. 4. DIAGRAM OF CIRCULATING PIPES TO AND FROM THE CONDENSERS

the difference in temperature being due to changing load conditions. The water in the hotwell varies in temperature from 140 to 150 degrees, so that it is 10 to 15 degrees hotter than at the nozzles.

In the cooling pond are arranged four branch pipes containing forty-eight 1½-inch Schütte & Koerting spray nozzles, there being 10 nozzles on two lines and 14 nozzles on the remaining two branch pipes. These pipe lines connect with a main header placed along one side of the pond, which in turn connects with the pipe leading from the condensers, as shown in Fig. 4.

Although the water comes to the spray nozzles at a temperature of about 125 degrees, the water in the pond remains at a temperature of about three degrees above the existing temperature of the atmosphere, both winter and summer.

In connection with the spray system of cooling the condensing water, a Wheeler cooling tower capable of handling 5000 gallons of water per minute has been installed. Both systems are used, depending upon the seasons of the year; for instance, during the winter months the spray nozzles and pond are used almost exclusively, a small amount of water being allowed to pass through the cooling tower, but the fans for circulating the air are not in operation. In the summer months, when the atmospheric temperature is high, the cooling tower is used.

Another interesting installation of jet-cooling sprays is in operation at the power plant of the Cambria Iron and Steel Works, Johnstown, Penn. The features of this system are the location of the spray nozzles and the manner of handling the water in cooling approximately 27,000 gallons per hour.

The condensing water is pumped to the spray nozzles through a 24-inch pipe by means of a centrifugal pump located in the power house at the foot of the hill. The horizontal pipe shown in Fig. 5 is made up of twenty 18-inch tees. Each tee is fitted with one 1½-inch Schütte & Koerting spray nozzle. These nozzles are set at two angles, every other nozzle being in line, as shown in Fig. 6. This brings ten of the spray nozzles at an angle of about 60 degrees, and the sec-

FIG. 5. SPRAY NOZZLES AND COOLING STEPS

ond set 30 degrees lower. The relative positions of the two sets of nozzles are shown at *A*, Fig. 7.

The spray-nozzle pipe reaches across the upper end of the cooling slope, which is 72 feet 6 inches wide, and 124 feet long. It is constructed of concrete steps located on a sidehill, as shown in Figs. 5 and 6. These concrete steps are 12 inches high by 12 inches wide. On top and at the edge of each step a strip of wood, 2 inches thick by 4 inches wide, is secured.

After the water is discharged from the spray nozzles, it begins its downward course to the bottom of the cooling slope, tumbling from step to step, and, striking the wooden obstructions on the outer surface of the step, is broken up as shown in Figs. 5 and 6. This gives the air a greater opportunity of cooling the water than if the step surface were smooth.

The difference in the temperature of the water is clearly shown by the amount of vapor arising from the water at the top and bottom of the slope. The water comes from the jets at a temperature of 120 degrees and is taken from the reservoir at the bottom of the slope at 80 degrees, a difference of 40 degrees.

At the bottom of the slope is a reservoir extending the entire width of the step and about 10 feet beyond at one end, as shown in Fig. 7. It is 5 feet wide and 3 feet deep at one end, and 4 feet deep at the other. Between this oblong reservoir and the intake to the circulating pump is a set of strainers which prevent the passage of refuse to the centrifugal pumps. The inlet to the circulating pumps is 6 feet deep. The reservoir at the bottom of the slope is provided with a 6-inch outlet for drainage to the sewer. A fresh-water connection is also made with the reservoir for replenishing the water lost by leakage and evaporation. The circulating pumps are in duplicate, and of the two-stage type. The system covers considerable space but since its installation has given the best of satisfaction.

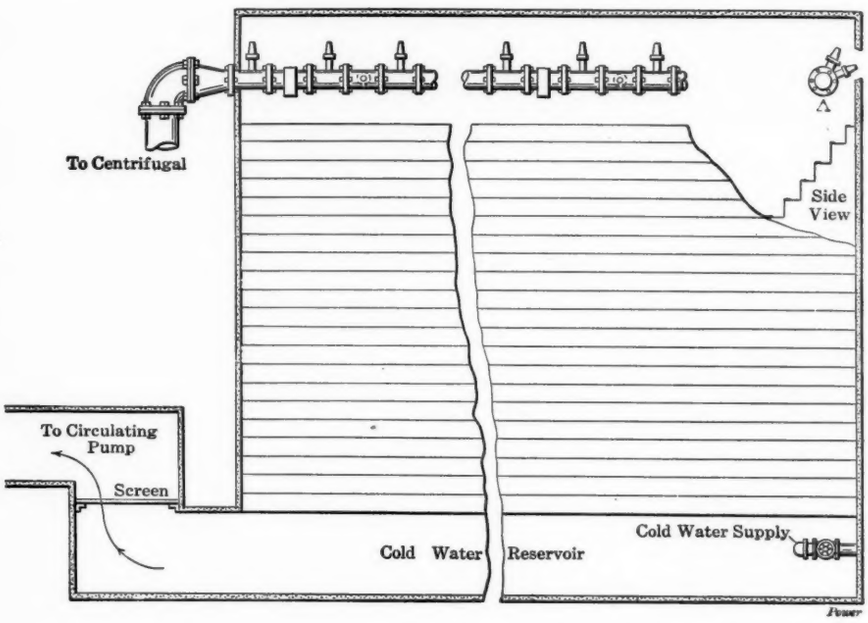


FIG. 7. DIAGRAM OF COOLING STEPS AND SPRAY NOZZLES

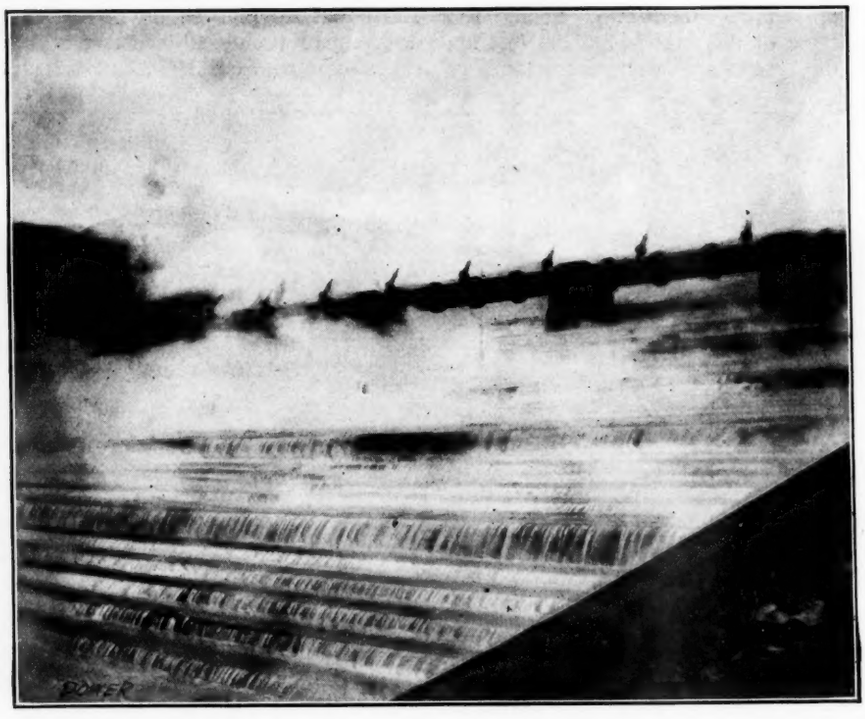


FIG. 6. CLOSER VIEW OF COOLING STEPS AND SPRAY NOZZLES

Coal Dust Explosions

A paper by Doctor Thorton and Mr. Bowden on "The Ignition of Coal Dust by Electric Flashes" was recently read at Newcastle, England. Experiments have shown that dry coal dust in bulk is a non-conductor of electricity, but when made into a paste with water it is liable to cause a short-circuiting flash if placed between electrodes. If a flash is produced —as by opening a switch—in a cloud of dust an explosion is produced. The character of the dust cloud and the strength and voltage of the current broken affects the readiness with which the dust is ignited, and at medium voltages direct current appears to be more dangerous than alternating. In view of the conclusive experiments on coal-dust explosions produced by the discharge of a cannon, as carried out at Altofts, the results described were to be expected.

O'Brien stepped into the door of Casey's engine room one morning and found that worthy member tinkering with a balky pump and swearing softly to himself. Thinking that he saw a good chance to "put one over" on him, he remarked: "Casey, ye'd bether kim over t' th' wather works tomorrer, they air goin' t' pull aff an intherestin' ingineerin' axperimint."

Casey looked up, and being caught off his guard by the innocent look on O'Brien's face, "bit" easily.

"What air they goin' t' do, O'Brien?" he asked.

With a broad grin O'Brien replied: "They air goin' t' dehorn th' hydraulic ram."

And the next moment he was busy getting out of the door just a few inches ahead of Casey's No. 10 brogan.

How to Make a Flue-Gas Analysis

By Julian C. Smallwood

The Orsat flue-gas analyzing apparatus and the manner of operating it is thoroughly described. Directions are given for preparing the chemical solutions which are used in the apparatus. Valuable hints are offered to assist the beginner to avoid common errors which influence the accuracy of the results.

Now that the steam-engine indicator has become important in maintaining economy of steam distribution, the operating engineer will the more readily believe that a knowledge of what goes on in his furnaces may result in economy of steam manufacture. Since a saving accomplished in the boiler room is of just as much value as a similar one in the engine room, it is well worth while to give some close attention to the place where the stuff is produced.

Without actually testing the boiler we cannot inform ourselves whether or not its heating surface and grate are acting efficiently. It may be easily determined, however, whether or not the coal is being properly burned, and, if not, how much waste is involved. With this knowledge it becomes simple to eliminate the loss. It is the purpose of this article to describe how such determinations are made and what can be done with them.

The process known as combustion is simply the quick combination of a burnable material with oxygen; the combination makes what we call heat. Coal is composed of some burnable material, chiefly carbon, and some that is not so, which appears as ash. The oxygen which the carbon combines with is in the air. What we know as air, however, contains more than oxygen; in fact, the oxygen composes only about one-fifth part of the air, the rest being nitrogen and a small proportion of water vapor and other gases. As a result of the combination of oxygen and carbon, either one or both of two gases may be formed, namely, carbon dioxide and carbon monoxide. These gases are commonly referred to as CO_2 and CO, respectively. As will be explained later, if monoxide is formed the combustion is incomplete and therefore all of the heat possible has not been obtained by burning the coal.

It may be well at this juncture to say something about heat. If it is understood, to start with, that heat is a purely relative thing, it will not be difficult to grasp the way in which it is measured. Thus, if you step into a room in which the atmosphere is at a temperature of 60 degrees on a hot day in summer it is felt to be cool, but if you come into a room having the same temperature in the winter it feels warm. Because of this relativeness of heat we cannot say that any material contains a certain amount of heat in the same sense that it has weight or length. But we can say that a body has a definite amount more heat than another body or has a definite amount more heat in one condition of temperature than another. This enables us to measure heat, and its unit is defined thus: The unit of heat (the British thermal unit, or, more shortly, B.t.u.) is the amount of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Using this unit, if one pound of water at 60 degrees is raised in temperature to 70 degrees it will have 10 B.t.u. more heat in it in the second condition than it had in the first. If ten pounds of water are heated through the same range of temperature 100 B.t.u. are added to it.

If a pound of coal is burned completely in such a way that all of the heat generated is absorbed by a known weight of water, then, by observing the rise of temperature of the water, it may be determined how much heat it is possible for the coal to produce. This sort of thing is done to determine the *heat value* of the coal.

All substances do not absorb equal amounts of heat during the same rise in temperature. Thus, if a pound of iron is heated from 60 to 61 degrees the amount of heat it has taken up is about one-eighth of that which the same weight of water would have absorbed. This quantity, one-eighth, is called the *specific heat* of the iron and for different materials it has different values. In any case the amount of heat in B.t.u. added to or taken away from a body is,

Weight in pounds $\times$ *range in temperature* $\times$ *specific heat.*

Now in burning coal for a boiler it is essentially necessary, in order to get all of the good out of it, to furnish enough oxygen to combine with all of the carbon so that it may be converted to carbon dioxide. In doing so we have to supply air containing four times as much nitrogen, which absorbs some of the heat of the coal and carries it up the chimney. This cannot be helped, but if we supply too much oxygen and the accompanying nitrogen, so much more heat is carried up the chimney which might otherwise be saved.

Further, and more important, if there is incomplete combustion we are not getting all of the good out of the coal that might be obtained. This loss does not show in the residue—burnable material appearing with the ash does not show *incomplete* combustion but *noncombustion*—but it does show in the flue gas. This, then, is the important thing to watch, and a knowledge of the proportions of its constituents enables one to make many useful calculations.

The most important constituents of flue gas to be determined are: Carbon dioxide (CO_2), showing complete combustion; carbon monoxide (CO), showing incomplete combustion; and oxygen (O), showing an excess of air or leakage in the flue. The remainder may be assumed to be nitrogen (N), although there is a number of other gases, originating from both the coal and the air, which form a small per cent. of the residue.

It may be noted that it is desirable to have the proportion of CO_2 present in the gas reasonably high for this indicates little excess of air. There are a number of automatic CO_2 recorders on the market, which enable one to keep track of the percentage of this gas. They should be regarded, however, as giving only a general indication of the efficiency of combustion for they convey no idea of the possible losses due to incomplete combustion. To judge only by the amount of CO_2 present is about as accurate as it would be to estimate the value of a pile of coins by counting only the gold ones. A general idea may be obtained by so doing, but possibly a very inaccurate one. It is erroneously thought that the higher the percentage of CO_2 indicated by these recorders, the better is the combustion. If the CO_2 is high it may be that too little air is supplied to the coal. If this is the case, incomplete combustion follows and a condition may be obtained where the resulting loss overbalances that from too much air.

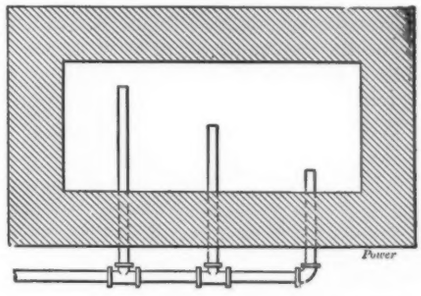


FIG. 1. ARRANGEMENT OF SAMPLING TUBES

The apparatus for analyzing flue gases depends upon the separate absorption of the gases named above by certain chemicals. A measured volume of the gas is brought into contact with one of these chemicals which removes from it the CO_2 but does not take up any of the other constituents. If the difference in volume resulting is divided by the original volume of the flue gas, the result is the proportion of CO_2. In this way the proportions of the three principal constituents are determined. The sum of these quantities subtracted from one gives the part of nitrogen, approximately. If the original volume contains 100 units as, for instance, cubic inches, the number of cubic inches of each gas then represents its per cent. of the total; that is, parts of one hundred.

The first step necessary in making an analysis is to obtain a representative sample of the gas. A short length of iron pipe may be inserted in the uptake so that it extends about half way across; through this the gas may be drawn. As the proportions are apt to vary at different points in the section of the uptake, it is better to use more than one pipe as shown by Fig. 1. Whatever combination of pipes for tapping is used, it should be placed as near as possible to the furnace to prevent dilution by air leaking through the brickwork. Great care should be taken to make the pipe joints tight for the same reason.

To obtain a sample various devices are used, the object of all of them being to collect the gas as it leaves the furnace in such a way as to exclude adulteration with anything else. Fig. 2 illustrates a convenient and easily made apparatus for this purpose. The bottle *S* is used to receive the sample. Its rubber stopper is pierced by glass tubes *T T'*, the shorter one of which is connected by light rubber hose *H* to the pipe leading from the uptake. The other bottle *R* is provided with the glass tubes and the hose connections as shown. The combination is placed upon a shelf near the outlet pipe *P* and a trifle below it. To obtain a sample, *S* is filled completely with water and *R* to about one-quarter of its depth. By blowing into *R* through *B*, water is forced through the hose connecting *R* and *S*, into *S* and up the hose *H* leading to the flue. In this way all of the air may be displaced from *H*. If there is any air in the other hose or in *S*, this, too, will pass through *H*. As soon as the pressure is removed from *B* the water will begin to siphon from *S* into *R*, and thus suck gas from the flue through *H*. The siphoning will continue until the water levels in the two bottles are the same. The gas should be collected very slowly; to do this the tube *B* may be choked with a cork pierced by a small hole. This causes the air to be displaced from *R* slowly, and consequently the water from *S*. When the sample is obtained the pinch cock *C* is closed and the bottles removed *together*. This is done so that when the gas is removed from *S*, water will be drawn in from *R* to supply the diminished volume in *S*.

Having obtained a sample of flue gas the next step is to introduce it into an apparatus for analysis. The most widely used one for this purpose is, perhaps, the Orsat, and this will be described. Referring to Fig. 3, *F* is a glass vessel into which the flue gas is drawn and measured. The gas is then caused to flow from *F* into the flask *D* in which is a chemical capable of absorbing the CO_2. It is then returned to *F*, measured, and the reduction of volume noted. This procedure is repeated for the determination of the other constituents, the vessels *M* and *O* being used.

To describe the operation in more detail, it is first necessary to displace all the air or other gas in the chamber *F* and the tube *T* leading from it. To do this a small bottle *B*, filled with water and connected with *F* by a rubber hose *H* as shown, is elevated. The water then flows from it into *F* and through *T*, but does not enter *D*, *M* or *O* because the glass cocks *d*, *m* and *o* are closed. When water appears at the outlet to the left of *f*, the hose leading from the sample bottle is attached at this point and the pinch cock on it released. Care should be taken in doing this that as little air as possible be entrained in the free end of the hose. The small bottle *B* is now lowered to the position indicated by the dotted lines, allowing the water in *F* to flow back into it. To fill the space vacated by this water, the flue gas enters through *T* into *F*, the whole volume of which should be filled with the gas. The cock *f* is now closed and the sampling bottle and connecting hose removed. One minute should be allowed for the walls of *F* to drain. The bottle *B* is then raised a trifle until the water level reaches the lowest graduation, 100. The pinch cock *p* is now closed. As the gas has been compressed by this rise of water level, the pressure should be relieved by opening *f* for an instant, allowing a little of the gas to escape. It should be noticed that if the pinch cock *p* is open the gas in *F* will occupy more or less volume according to whether it is expanded or compressed by lowering or elevating the bottle *B*. It is therefore necessary when reading the volume to have the water level in *B* the same as that in *F*, and this may be accomplished by holding the bottle *B* so that the levels coincide when the readings are made.

We have now secured a sample of gas in the apparatus which is neither expanded nor compressed. The amount of it by the graduated scale is 100 "c.c.," c.c. referring to the French unit of volume, cubic centimeters. This unit is about one-sixteenth of a cubic inch.

The next step is to introduce the sample into the flask *D*. To do this *d* is opened; the bottle *B* is elevated until the water level in *F* rises to the mark *n* and the pinch cock *p* is closed. The water entering *F* forces the gas into *D;* the entering gas in turn presses the chemical out of *D* up into *D'* through the connecting pipe at the bottom. Flask *D* contains a number of glass tubes which remain wet with the chemical, thus furnishing a large area to absorb the CO_2. The liquid entering *D'* thereby displaces the air previously contained. This air passes into the rubber bag *R* and expands it. The function of this bag is, first, to keep the chemical from contact with the outside air (such contact would rapidly use it up); and, second, to provide a means, if necessary, to force the chemical back into *D*.

Having filled *D* with the sample, it should remain there at least three min-

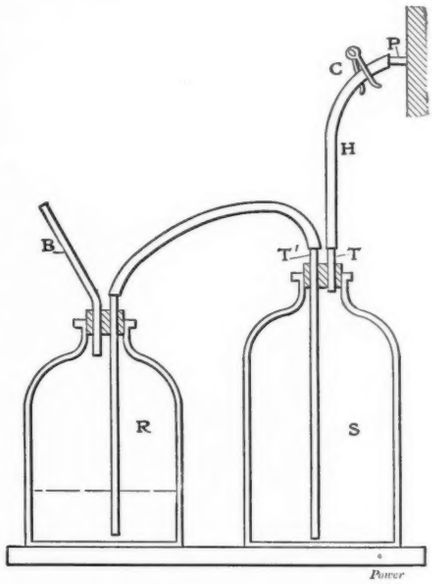


FIG. 2. SAMPLE-COLLECTING APPARATUS

utes to allow time for the thorough absorption of the CO_2. The gas is then returned to *F* by lowering the bottle *B* and opening the pinch cock *p*. If necessary, the rubber bag is pressed so that the level of the chemical in *D* returns to the mark *a*. When this is done the cock *d* is closed; the bottle *B* is held alongside of *F* so that the water levels are the same, and a reading taken. If, for example, the reading is 87 c.c., the volume of CO_2 that *was* in the sample occupied,

$$100 \text{ c.c.} - 87 \text{ c.c.} = 13 \text{ c.c.}$$

or 13 per cent. of the entire volume.

The procedure described is repeated in each of the flasks *O* and *M*. The chemical in *O* removes the oxygen from the gas; that in *M*, the CO. What is left is called nitrogen. The difference between the volumes of the gas before and after entering *O* gives the volume of oxygen. In a similar manner the volume of CO is obtained.

The chemicals used are as follows:

For carbon dioxide, one-half pound of

caustic potash dissolved in one pint of water. The caustic potash is a solid and is sold in the form of sticks. It should be kept in a corked bottle and should not be freely handled as it attacks the flesh. This chemical, as used, will absorb forty times its own volume of CO_2.

For oxygen, one pint of the caustic potash solution as just described, to which is added five-eighths of an ounce, avoirdupois, of pyrogallic acid. This is a powder and may be poured into a bottle containing the measured caustic potash and water. This bottle should then be kept corked to prevent the contents spoiling. The absorptive capacity of the mixture is twenty times its own volume.

For carbon monoxide, the necessary solution may be prepared by placing in an open-mouthed pint bottle, such as one used for milk, one ounce of copper oxide and a bundle of copper wire a little shorter than the bottle in length and in diameter about half that of the bottle. To this should be added commercial hydrochloric acid sufficient to cover the wire. The bottle is then corked. When the solution becomes colorless it is ready for use. The absorptive capacity is twice the volume of the mixture.

When pouring these chemicals into the proper vessels of the apparatus, the rubber bags and the corks are removed from them, and the cocks *d, o, m,* and *f,* Fig. 3, opened. The chemicals should be poured in until the level is about half way up in the connected flasks as shown at *k k*. By manipulating the bottle *B* all of the CO solution, for instance, may be drawn into the flask *M*, the cocks *d, o* and *f* being closed and *m* open. The cork and attached rubber bag may then be replaced and the cock *m* closed.

The foregoing outlines the procedure of flue-gas analysis by the Orsat apparatus. A little study of and practice with the actual apparatus will result in its complete understanding. There are, however, some common mistakes easily made and not readily detected that may influence the results materially. The following gives a few points in practical operation:

Carbon dioxide should be removed first, oxygen next and monoxide last. If this order is not kept the results will be wrong. The chemical that removes oxygen will absorb carbon dioxide also; therefore the latter should not be present when oxygen is dealt with. A similar error would be produced by testing for carbon monoxide first.

The analysis should be made at a uniform temperature of not less than 60 degrees. The apparatus, when in use, should not be exposed to a changing temperature, or placed where drafts or sun may strike it. The resulting changes of temperature cause expansion or contraction of the gas under test, and any such change in volume will make the results untrustworthy.

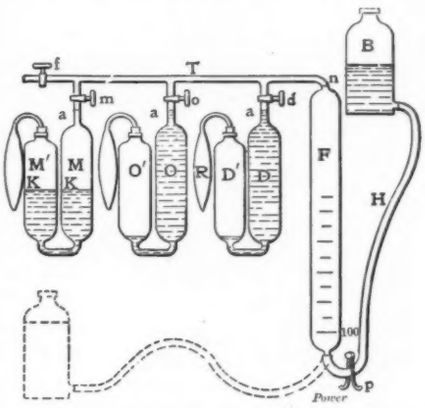


FIG. 3. DIAGRAMMATIC ARRANGEMENT OF THE ORSAT APPARATUS

The water that is brought into contact with the gas should be prevented from absorbing any part of it. Water has the property of absorbing the gases and if any part of a sample is removed by water, the analysis will not represent the gas as it came from the flue. To prevent the water used in the apparatus from affecting the results, it should be previously saturated with flue gas so that it is incapable of absorbing more. This may be done by connecting the sample bottle, containing a charge, with the apparatus and alternately raising and lowering the bottle *B*, Fig. 3, so that the gas is worked in and out of chamber *F*. The water used in the sample bottle may be saturated with the gas for the same purpose; or, if preferred, a drop of oil introduced into the sample bottle will cover the surface of the water in it and separate it from the gas.

When removing the sample bottle *S*, Fig. 2, from the flue it is well to siphon back into it some of the water from *R*, the pinch-cock *C* being closed. This puts the gas in *S* under pressure and if any leakage takes place past the rubber stopper it will be outward and will not affect the sample as would be the case if air leaked inward.

After the chemicals have been used for some time they become weak. If a record is kept of the volume of the gas each has absorbed, it will be known when its absorptive capacity is reached; it should then be discarded.

It is well, after making a measurement, to run the gas back into contact with the chemical it has just left, and allow it to remain a minute. Upon measuring again, if the volume is the same, the result is satisfactory. If, however, a check reading of this kind shows less volume than the previous one, it must be because the gas has not had sufficient contact with the chemical to remove all of the constituent being measured. The treatment should then be repeated until a constant volume is obtained. This precaution is particularly necessary in determining oxygen as the solution acts slowly.

In measuring the water level in *F*, Fig. 3, it will be noticed that where the water meets the sides of the vessel it clings to it and is slightly higher than the level at the middle; that is, a rounded surface is formed instead of a flat one. The lowest point of this surface should be sighted on the graduating lines and the corresponding graduation read.

Oil Grooves and Bearing Lubrication

By William Kavanagh

A hollow crank pin and one of the means by which it is oiled is shown in the dotted lines, Fig 1. A hole is bored centrally and longitudinally up to the collar *C*, as indicated by the dotted lines. The diameter of hole *A* is of sufficient size to admit the entrance of a brass tube *B*, which is filled with oil or other lubricant, the length of the tube being nearly as long as the hole in *A* in the crank pin. Both ends of the brass tube are closed, and to one end is attached a small ring, so that the tube can be withdrawn by means of a small hook. Three holes are drilled in the tube as shown at *X*. The end holes are vent holes, the center one being the filling hole.

In order to fill the tube with oil the screw plug at *D* is removed and the tube loaded with oil or other lubricant. The plug *B* should be screwed up medium hard. The oil from the tube finds its way out through the holes *X*, through the hole *E*, and then passes in between the pin and brasses. The tube is filled before starting the engine.

When the engine is running over, the tendency of the crank-pin box on the strap end is to wipe off nearly all of the lubricant, especially when the boxes are not properly fitted, as shown in Fig. 2, which shows the sharp edges of the brass at *E E*.

When the engine is running under, the brass on the connecting-rod end acts as a wiper in the same manner if not properly fitted.

At *F F*, Fig. 2, the sharp edges shown at *E E* are removed for either direction of rotation.

A great variety of oil channels are cut in boxes, according to different ideas. Some fitters prefer a cross, shown at *A*

in Fig. 3, others a V or a T channel, shown at *B* and *C*, respectively.

Where high-speed bearings give trouble from heating, a double or single spiral may be cut in the shaft, which, if properly done, will aid materially in reducing heat. In cutting the spiral, care

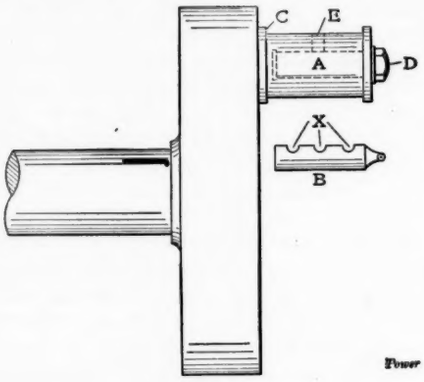


FIG. 1

should be taken not to extend it outside of the box, as in such case oil will be thrown. One way of cutting a spiral is shown in Fig. 4, the lines *A* and *B* determining how near the end of the box the spiral may be cut.

Most ring oil bearings that heat do so from two or three causes aside from excessive friction or load. The rings may cease rotating; lack of oil in the oil well, the oil becoming dirty, or the use of a heavy oil, especially if there has been any cylinder oil added to the regular machine oil used in the bearings, will cause heating. When the oil is thick and sluggish it stops the rings rotating and prevents lubrication. When a ring-oiled bearing runs hot, perhaps the oil is

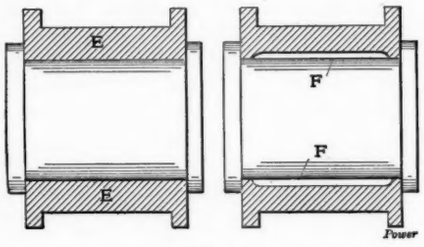


FIG. 2

worn out and should be changed. All of the old oil must be run out and the well washed out with some good mineral oil. After filling the well with clean oil, it will be found that the bearing, in nearly every case, will cease running warm.

Babbitt metal melts easily and at a sufficient temperature becomes soft and is easily crowded out of the box in the direction of strain. With belt-driven shafts the babbitt metal will become thin in the direction of the pull of the belt, and, therefore, the soft-metal bearing is not very reliable, especially where a bearing must run. In the writer's plant all soft-metal bearings were consigned to the

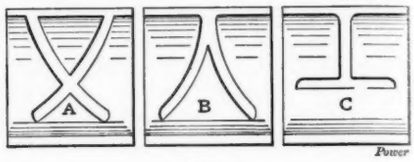


FIG. 3

scrap heap long ago, and only hard brass sleeves are used. They permit of a high temperature before trouble is given by heating and, besides, give a warning

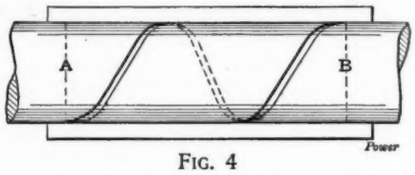


FIG. 4

which can be heard in time to prevent trouble. If the oiler wishes to save about 50 per cent. of his labor and waste, let him use waste after wetting in clean water; the rapidity with which the oil is wiped off a surface is astonishing.

Leather for Belting Purposes

By Frederic Dannerth

The best belting is obtained from a particular section of the hide and must go through numerous processes before it is suitable for the transmission of power. The various processes which transform the raw hide into the finished belt are enumerated, and some valuable hints are given on the use of belt dressing and the care of belts.

Before entering upon a discussion of the requirements of leather belting it may be of interest to review briefly the processes through which such leather passes before it is in the proper condition to be made into belting.

First, the skin is removed from the animal by a machine and is soaked in lime water to loosen the hair by swelling the pores. Then it is beamed, that is, all the hair and outer skin are removed by means of blunt knives operated by hand, and after being washed it is bated; this is usually accomplished by the use of lactic acid, its object being to remove any lime which may remain on the skin. It is next pickled in a bath containing sulphuric acid and sodium chloride, which treatment enables the fiber to take up the tanning material much better than would otherwise be the case. The skin is tanned in a bath containing white-oak bark, at a temperature of 80 degrees Fahrenheit and is then laid away for a period of about six months, in ground bark with just enough water to cover it. In trimming the leather, all of the shoulder is removed to within 4 feet from the base of the tail, as is also the belly, the loose character of the fiber rendering this leather unsuitable for belting.

After being removed from the tanning process and trimmed, the leather is reeled in fresh water and shaved by a machine which removes all the loose particles of flesh projecting from the surface. A scouring process removes the "bloom" caused by excess of tanning material and also puts the leather in condition to take up the necessary grease. Next it is jacked and sammied and is placed on stretching frames where it remains until perfectly dry. Upon being removed from the frames it is cut into the desired widths with an allowance for trimming. Here it might be mentioned that all leather for first-class belting must be cut from "center stock" which should show the demarcation produced by the backbone and which should not be wider than 30 inches nor longer than 4½ feet.

A scarfing machine and a lapping machine are both used to put a lap on the leather, while another machine removes the grease from the flesh side; this latter operation is called whitening and is very necessary as the cement otherwise would not grip the leather. The several pieces of leather are now ready to be cemented together, an operation requiring a pressure of about 20 tons.

If the finished belt is to be wider than 30 inches, it is necessary to make it two or three ply. For example, a 60-inch belt might be constructed as follows: The first ply, consisting of three pieces of leather each 20 inches wide and lapped longitudinally, the length of this section being about 4 feet; the second ply, consisting of one 36-inch center united on each side with one 12-inch center, all 4 feet long; while the third ply consists of two 30-inch centers lapped longitudinally and, like the others, 4 feet long. The accompanying illustration may help to make this clear.

"Belting butt" is the term applied to

that portion of the hide which remains after those portions of the hide unsuitable for belting (neck, belly and flank) have been cut away, this trimming constituting about half the weight of the hide, as before mentioned. The stuffing of the leather with oils or grease is carried out after the leather has been placed on the stretching frames and is done to render the butt flexible. In some cases this stuffing is supplemented with a loading of glucose, sugar of lead and fats. The result of this is that we may find two pieces of single belting, one weighing 26 and the other 18 ounces per square foot. High-grade belting should not wrinkle nor "pipe" if bent back and forth repeatedly at a sharp angle. Fat wrinkles are such as appear at the ends of laps and are not objectionable; in fact, they are seen in the best grades of belting. Another point to be observed when examining belting is its "trueness," as a good belt should lie quite flat if placed on the floor and should be of uniform thickness. By carefully sorting the butts it becomes easy for the belt manufacturer to produce various grades of belting, but after the belt is once made up it is difficult to recognize poor or low-grade beltings at a casual glance.

After once having purchased the belt and placed it in position it will be noticed that there are two principal causes of loss in power transmission, namely: *tightness* and *slippage of belts.*

The slippage may be ascertained by taking the speed of the various lines of shafting at full load and again at no load. *Chase* has calculated the actual money loss for a mill with 1000 looms, turning out 5000 pieces of print cloth per week, with a belt slippage of 29 per cent. prevailing, and he finds the weekly loss to be 100 pieces valued at $2 each. One of the immediate results of a tight belt is a hot bearing; hence, many engineers run the belts so that slippage is just overcome and then, at a certain time of the year, a systematic shortening of the belts in the mill is undertaken.

If any belt is wasting power in friction in a manner which can be easily remedied, that belt is obviously too tight. A belt may be considered sufficiently tight if it does not slip and has sufficient pulley contact to keep within the strength of the leather and withstand the strain placed upon it.

Belts cut from center stock run smoothest and straightest, and are therefore recommended for use with high speeds (30 feet per second and over). In 8-inch widths such belts can be produced in thicknesses of 6/32 to 7/32 of an inch; this is due to the fact that the hide along the line of the backbone is rather thin. Belts which are to run at slower speeds may be cut from the part directly adjoining the absolute center, for in this case the tension on the fibers in the different parts of the belt will have opportunity to equalize. Such belts not cut from absolute centers should not be 8 inches in width, otherwise the tension on the two edges of the belt will be unequal and the belt will not run true. In cases where loose pulleys and fixed pulleys are employed, the greater tension on one edge of the belt is utilized by placing the belt in such a position on the loose pulley that the tighter edge adjoins the fixed pulley. The advantage of this lies in the fact that it is easy to run the belt on to the driving pulley but difficult to throw it back to the loose pulley.

The quality of a belt depends upon its strength, durability and its driving power, but these cannot be determined by the thickness or the weight. The ability to transmit power is determined by the tensile strength of the leather and its elasticity as well as the character of the drive. The strongest part of leather is located about one-third the distance from the flesh side but the action on the belt is greater on the inner half of the leather. For this reason and also because the leather is thus used in its natural position, the flesh side of the leather is placed preferably against the pulley.

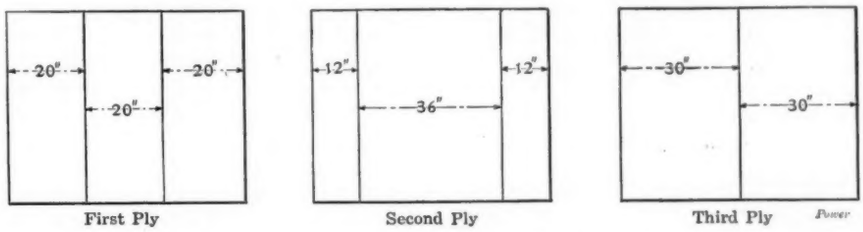
There is at this time a distinct difference of opinion among engineers regarding the value of belt dressings. While some insist that all belting and especially leather belting should be treated periodically with such preparations, there are others who maintain that they should be avoided or used sparingly. It seems, however, that this second group base their statements upon their experience with low-grade dressings containing rosin and similar harmful substances. *S. von Bach* recommends that leather belts be degreased periodically and that they should then be given a small amount of belt dressing free from rosin.

Belts after being installed attract dust which prevents proper contact and so interferes with adhesion, or they become glazed and then slip. These defects may be remedied temporarily by tightening the belt, an operation which results in greater strain on the bearings and a misuse of power for overcoming the increased friction. Commercial belt dressings are used for making the belt stick to the pulleys and to preserve the belt. The substances used in manufacturing these preparations include stearic acid, degras, rosin, castor oil and fish oils.

Properly curried leather belting, used under the right conditions, will seldom become dry and hard. In certain cases a dressing containing 70 per cent. tallow (free from acid and having a melting point of about 95 degrees Fahrenheit) mixed with 30 per cent. castor oil has given excellent results. If it is found necessary to use a preparation of this kind it should be used sparingly as the use of oil and grease tends to make the leather stretch. Such a mixture as indicated above will soften the fibers and at the same time increase the adhesion of the belt. If it is desired only to correct slipping this may be done by applying a few drops of castor oil to the pulley, without fear of injuring the leather.

The small amount of slip which is bound to occur on the pulley side of the belting produces heat, which causes that side to become dry and hence further slipping. Careful tests seem to indicate that the coefficient of friction is influenced directly by the absence of air or other substances between the belt and the pulley and that the best results are obtained when the belt is in direct contact with the pulley. For this reason the belt dressing should be used very sparingly in order to avoid any reduction in the gripping power of the belt. All dressings of a sticky or oily nature will attract dust and this gathers in clots on the pulley or on the belt with the result that the belt runs unevenly, at the same time decreasing the area of contact. If a newly installed belt has stretched excessively, it should not be shortened immediately but should be treated on the pulley side with beef tallow. This causes the belt to slip somewhat but the frictional heat soon liquefies the fat which is then gradually absorbed by the leather. The swelling of the leather due to this absorption causes a shortening of from 1 to 2 per cent.

In conclusion it may be said that a good dressing should not decompose, become rancid with age, be influenced by moisture, dry up nor cause the belt to stick to the pulley, but should soften the pulley side of the belt, penetrate the belt, leaving no film on the surface, lubricate and protect the fibers from crumbling, prevent the generation of electricity by the belt and increase the coefficient of friction. Also, it should contain no mineral acids. A dressing fulfilling these specifications will not injure the belt and may be used with impunity.



METHOD OF CUTTING PLIES FOR 60-INCH BELT

Notes on Western Anthracite Coal

By A. G. Christie

As is well known, some types of mechanical stoker are better adapted to burn certain kinds of coal than others. This is confirmed in the present case where much difficulty was experienced in attempting to burn No. 2 buckwheat coal on a Roney stoker while a mixture consisting of No. 1 buckwheat and pea coal was found to give satisfactory results.

Pennsylvania anthracite coal has been used for so long a time and under so many varying conditions that engineers now know what type of furnace to construct, what class of grates to use, and how the fire should be handled in order to give the best efficiency with any given size of coal. This coal is almost free from hydrocarbons and hence burns practically without smoke. In mining, this coal usually has fairly well defined partings so that the bone can be separated readily from the good coal; the ash as a rule is friable and forms a very small percentage of the coal. The anthracite coals found in western Canada, and particularly in Alberta, have quite different characteristics from the Pennsylvania anthracite.

The Alberta coalfields, as far as they have been prospected, cover an area about 400 miles long and from 100 to 200 miles wide. Almost every variety of coal is found within this area from the anthracite coals of the Bow river section and the newly discovered Brazeau river sections to the brown lignite of the prairie. The coking coals of the Crow's Nest district are well known and are used to a great extent by the smelters in British Columbia, Idaho and Montana.

At present the only anthracite deposits being worked are located at Bankhead, Alberta, a few miles from Banff, the famous scenic resort. These deposits lie under the eastern slope of Cascade mountain and, as is common in most Western mines, only the seams of the upper formations are being worked. This may account for the fact that the coal is more truly a semi-anthracite than a pure anthracite, better grades of anthracite being known to exist in the lower seams. The coal is hard and does not weather, nor does it possess the shiny black appearance of Pennsylvania anthracite. At times there is considerable shale, often in very thin seams in the coal itself. An analysis of the coal is as follows:

	Per Cent.
Moisture	2.1
Volatile matter	8.1
Fixed carbon	79.3
Ash	10.5
Sulphur	0.6

Attention is called to the high ash content and the per cent. of volatile matter.

A process has been developed at this mine by means of which all the small coal and dust is briquetted, the coal-tar pitch being used as a binder. The briquets are "pillow shaped," ¾ inch long and about the same width and thickness. They are excellent for domestic purposes, leave little ash and command a high price.

Attempts to burn this Bankhead anthracite were made at the plant of a large cement company located within the Rocky mountains, about 25 miles from Bankhead. A very fine grade of semi-bituminous steam coal was mined in great quantities only ten miles away at Canmore, but the whole output of the mines is taken by the Canadian Pacific Railway for use on its locomotives.

The boiler plant consisted of seven Babcock & Wilcox boilers, set in batteries of two each with an extra boiler set alone, each with 4980 square feet of heating surface and equipped with superheaters to give 100 degrees Fahrenheit superheat. These boilers furnished steam for driving the turbo-alternators and reciprocating engines which produced power for the mill and quarry.

When the question of furnaces came up, it was decided to install Roney mechanical stokers for the following reasons: First, the manufacturers were willing to guarantee that these stokers would burn Bankhead No. 2 buckwheat coal satisfactorily and produce the rated capacity of the boilers; second, the cement company owned large coal areas of both anthracite and soft coal and had plans under consideration for opening these, hence, a furnace was desired which could handle either class of coal, and the Roney stoker was deemed capable of doing this; the third and most important reason was the belief that cheaper labor could be used in the operation of mechanical stokers and with more satisfactory results. This judgment was fully justified in actual operation. At first only four boilers were equipped with the old style of stoker having flat plates, though later the remaining three boilers were equipped with the new-style stoker having vertical fins pinned to a yoke. The arch over the furnace was extended by two rows of brick in excess of what was then considered good practice.

After passing through the regular baffles the flue gases passed down the back of the boiler and into a concrete smoke flue which was built under the boilers and led to either of two 16-foot induced-draft fans placed at one end of the boiler room. These fans were engine driven and discharged the gases through a short 10-foot steel stack. The engines were of a slow-speed type, direct-connected to the fans, either of which was capable of handling all the boilers. The speed of the fan was governed by a pressure-regulating valve on the steam line to the engine, which valve cut off the steam as the pressure in the boilers increased; by altering this regulating valve any desired draft could be obtained.

The illustration represents a section through the boiler room showing the relative arrangement of coal bunkers, boilers, stoker settings and smoke flues. Coal was drawn from chutes in the bottom of the bunker, transported on cars to the fronts of the boilers, and then shoveled onto the stokers by hand. The ashes were shoveled from the ashpits and loaded on similar cars which were pushed out onto the ash dump.

As is obvious, this arrangement necessitated a large amount of manual labor; in fact, the operating force outside of the boiler cleaners averaged eight men to a shift. It may be of interest to add that one man looked after the whole of the engine equipment and condensing machinery together with the switchboard, except for occasional supervision by the engineer in charge. The load on the plant, though steady compared to many railway central stations, varied considerably at all hours, and without notice; the day load was much heavier than that at night as the quarries, crushers and unloading conveyers were then in operation.

From Fig. 1 it will be seen that the only method of removing ashes was to shovel them from the bottom of the ashpit by a long-handled shovel. This removal of ash required a great deal of labor on account of the character of the ash. As has been remarked, the coal always seemed to carry considerable shale and bone. In burning, this seemed to sinter the various pieces of coal, and formed large masses of porous ash and clinker often of large size but as a rule very light in weight. However, the ash equaled volumetrically about 50 per cent. of the coal fired.

This outline gives a rough idea of the conditions existing in the plant. One point further needs to be emphasized and that is the poor class of labor available, which consisted either of newly arrived immi-

grants or of what is known in the West as "hobo" labor. The first class consisted largely of men from the British Isles who retained that inborn trait of altering habits and adjusting themselves slowly to new conditions. Many of the men employed in the boiler room were firing for the first time, and at times only foreigners were available, although some of these became very adept firemen. As labor was scarce, men of the hobo class were always being taken on. Often these men could fire well, but they could never be depended upon to stick to a job and usually left as soon as they had accumulated a little money. Hence, labor costs were high and results often discouraging as the operating staff were always breaking in new firemen, at which time the fires were often full of holes and large quantities of good coal were lost in cleaning the fires.

Naturally when the plant was first started, the cheapest coal, No. 2 buckwheat was tried. At first, difficulty was experienced in getting this coal to take fire all over the top of the grates; this trouble was attributed to the volatile matter being small and easily burned only at a high temperature.

The clinkering action of the ash, which has already been referred to, did not take place unless the fire was good and the temperature high. As there was no coking and as the draft necessary to burn this size of coal was high, trouble was encountered with the coal slipping to the dump grates at the bottom of the stoker. This produced several undesirable results: First, the coal piled up to such a depth at the bottom of the furnace that little combustion took place; second, as a result of the air passages being almost entirely cut off at the bottom of the furnace, the draft became more intense through the upper portion, and more of this small coal was carried to the bottom. Unless the draft were checked the grates would be swept bare and large volumes of cold air would pass into the furnace. It was impossible to put on any grate motion to provide air, as is usual on these stokers using soft coals, for this only made the coal work more quickly to the bottom of the furnace. The most serious trouble was the loss through unburned coal which frequently necessitated picking over the dump and returning the unburned portion to the hoppers. Another very troublesome feature was the formation of huge clinkers, caused by fresh burning coal sliding over partially burned-out ash; these were often hard to break up. The removal of these clinkers almost always required the opening of the side door and this produced a serious cooling effect upon the boiler in spite of a closed damper. Very often the poking necessary to remove these clinkers caused a slide of fresh coal from above.

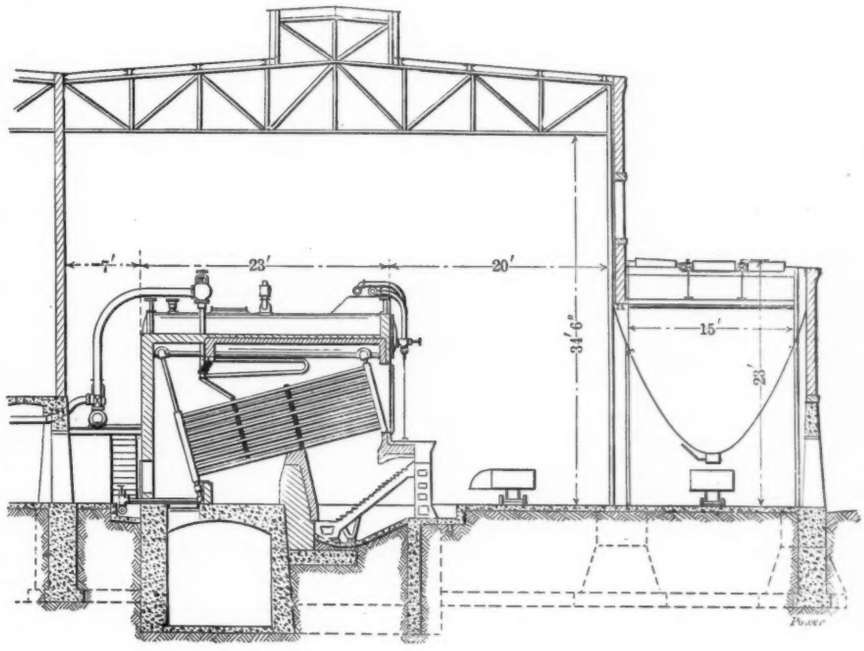
It seemed probable that these troubles could be overcome if the angle of the grates with the horizontal were changed from 40 degrees to about 25 degrees. Accordingly, the grates under one boiler were lowered slightly in front and raised about a foot at the rear. This, however, did not prove as successful as had been anticipated; the very fine coal sifted back through the flat grate bars, for on account of the raising of the rear end these dipped down toward the front of the furnace. This loss almost equaled that met with in dumping at the original angle. Besides the grates had been made too flat, for the coal did not work down easily without considerable poking.

While this experimenting was going on, the mill was gradually being placed in operation. Since at all times one or more of the four boilers had to be out of service for cleaning, it was found necessary to install hand-fired grates under the single boiler, pending the arrival of the remaining mechanical stokers. As this was only a temporary arrangement, flat stationary grate bars were installed. Here, as in driers in different parts of the cement mill, it was found extremely difficult to keep a good fire and then only with the most skilful firing. Holes formed very readily, and after cleaning, it was hard to prevent this very fine coal from sifting through into the ashpit and leaving the grate bars bare.

About this time the coal company, which had had its briquetting plant in operation for some time, found that it was more profitable to make the No. 2 buckwheat into briquets than to sell it for power purposes. As the cement company had no fixed contract, the supply of No. 2 buckwheat was gradually reduced, and No. 1 buckwheat was supplied in its place. This cost 25 cents more a ton than the No. 2 buckwheat, but it was cheaper coal even then when completeness of combustion was considered. But during inactive periods at the mine in the spring and early summer, the cement company was forced to buy pea coal along with the No. 1 buckwheat then available. The firemen soon learned to burn the latter with very satisfactory results, while a mixture of two parts of No. 1 buckwheat and one of pea proved to be the best firing mixture.

When the second set of stokers of the improved type arrived, No. 2 buckwheat was again tried, and while better success was obtained than on the old type, the results were not satisfactory enough to warrant its further use owing to the sifting of the coal through the grate bars.

The methods employed in handling the fires with No. 1 buckwheat and pea coal were as follows: The dumps were always made with a very hot fire on the upper grates and the firebrick arch and side walls intensely hot. The damper was nearly closed and cooling thus avoided as much as possible during a dump. As soon as the ash and clinkers on the dump grates had been poked out, the grates were pulled up, and the clinker, which had been loosened previous to dumping, was pushed down with a slice bar. At the same time a heavy feed of fresh coal was put on the pusher bar, and the grates were always kept covered with coal. The presence of the hot firebrick arch caused a rapid ignition of the fresh coal and a good fire could be had within a short time. Then from time to time the fireman would break up the clinker and work it toward the dump grates, at the same time maintaining a steady feed of fresh coal. This would continue until dumping was again necessary. These sizes of coal were large enough to lie



SECTION THROUGH BOILER PLANT

on the grates at all times, and did not avalanche under heavy draft. It was also noted that fewer and smaller-sized clinkers were formed on the improved type of stoker.

No. 1 buckwheat coal burns with considerable yellow flame but without smoke if the furnace temperature is kept hot. It has a tendency to form clinkers often of large size but not of a tenacious nature. Large quantities of dust are carried over the bridgewall and even into the fans. A very fine white dust collects on the lower side of the tubes above the furnace, sometimes to a depth of ½ inch in three weeks. This reduces the steaming capacity and requires careful and frequent cleaning.

The fans were usually run at a speed to maintain a draft of 0.6 to 0.8 inch of water at the fans and the dampers were regulated to give a draft of 0.3 to 0.5 inch above the grates. This was found to give the best results in ordinary operation, as an increase of draft tended to make the coal slide down the grates.

The daily records show that the average amount of coal burned ranged from 15 to 20 pounds per square foot of grate surface on the stoker. No tests were run on the boilers, but it is reasonable to assume that their average load under these conditions seldom exceeded their full rating.

During the early part of the summer the supply of coal from Bankhead became insufficient on account of the partial closing down of the mine. It was then decided that the cement company should open up some of its own bituminous-coal properties. While this mine was being opened, coal was secured from many sources, and a brief reference to these coals and their burning qualities on Roney stokers may be of interest.

Several carloads of Canmore coal were secured. This coal is used exclusively in the locomotives on the Canadian Pacific railway, and has proved an excellent steam coal. It is a semi-bituminous, noncoking coal and slacks on prolonged exposure to air. As the coal secured was principally slack and did not coke, it was not found to be a suitable coal for mechanical stokers. Another peculiarity noticed was that if Canmore coal became mixed with Bankhead coal in the furnace, hard clinkers of large size usually resulted.

For some time coal from Coal Creek and other mines in the Crow's Nest district was burned under the boilers. These are bituminous coking coals especially suitable for Roney stokers. Heavy drafts and high combustion per square foot of grate could be maintained even with slack coal. This coal filled every requirement had the freight charges not made the cost prohibitive.

Another coal used was known as "Hillcrest coal," coming from the Lethbridge district. This was a noncoking, bituminous coal which gave an intensely hot fire with little smoke and left the least ash of any of the coals. The ash was of a powdery nature and gave little trouble. This was probably the most satisfactory coal of all, but was too expensive when freight charges were paid.

The cement company, in developing its bituminous-coal property, opened up a mine in an outcropping which was very accessible for mining and shipping without the employment of hoists and other machinery. This coal proved to be a black lignite with high moisture and high volatile contents. It produced large volumes of dense black smoke, but was found to burn better on the new style of stoker than on the old style. It ran very high in ash and showed tendencies to coke. The coal, however, improved greatly in quality as the mine became deeper. Seams of high-grade coking coal are known to underlie the one being developed, but have not as yet been touched. When coals of lignite character are to be burned in Roney stokers, the furnaces should be set out considerably in front of the boiler and a reverberatory arch of considerable depth should be built up; then little smoke and good economy can be secured.

Bankhead coal is burned in a large number of plants throughout western Canada, on both stationary and shaking grates in hand-fired furnaces. In one place, a Dutch-oven type of furnace with shaking grates has proved satisfactory for almost any size of this coal. In another plant, steam blowers are used under the grates in conjunction with chimney draft and a very good economy obtained. Furnaces of the Parsons type should be very suitable for this coal. Bankhead coal is also used to a large extent in many gas producers of American, Canadian and European manufacture and has shown very favorable results.

The foregoing records a single attempt to burn a variety of anthracite coal on one type of mechanical stoker. It is possible that the type of furnace might have been altered to advantage, and that there are methods of handling the coal in these stokers which were not tried. It would seem justifiable to conclude that the Western anthracites do not adapt themselves to use in mechanical stokers, while practically all the Western bituminous and lignite coals are well suited to this type. It would also seem that a reverberatory furnace having grates equipped with a steam blower would not only provide a satisfactory means of economically burning this small anthracite coal but would also reduce the tendency to clinker.

Packing Condenser Tubes

By George H. Gibson

To pack condenser tubes so that they shall have free movement in the tube plate to provide for expansion and contraction without the possibility of leakage is not so simple a problem as it might seem, but it has been solved by the type of joint described in the following.

The tube plate of the Wheeler surface condenser is bored to two diameters, one large enough for the tube, the other ¼ inch larger and threaded to receive a screw ferrule. These ferrules, which encircle the ends of the tubes, have inwardly projecting lips which prevent the tubes from creeping out of the plate at either end. In order to secure a watertight joint between the tube plate and the tube, a certain grade of corset lacing used as a packing has been found to be the best packing.

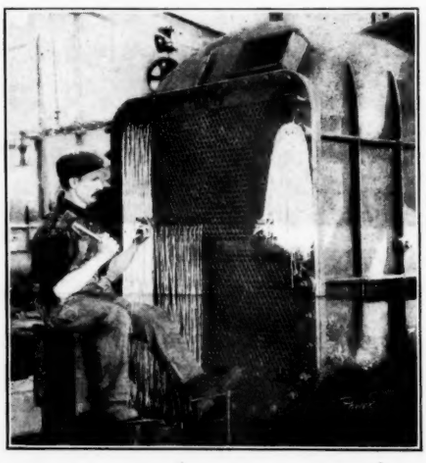


FIG. 1. PACKING CONDENSER TUBES

This lacing requires a special treatment to render it entirely suitable. Some people use tallow for lubricating the packing, but if not of the best quality this may become rancid, breaking down into organic acids which corrode the tube. Too much lubricant causes binding while too little leads to breaking of the ferrules. The fiber of the corset lacing supplied by the makers of the above mentioned condenser, is thoroughly permeated at boiling temperature with just the right amount of paraffin, the exact amount being determined by weighing the lacing before and after treatment. A machine squeezes out any excess, so that it is difficult to tell by handling the lacing whether it has been paraffined or not. The corset lacing is then cut into the right lengths for packing the tubes.

This prepared lacing permits of rapid

work, as it gives just the right amount of properly lubricated packing for each joint.

There are several special devices for inserting the packing in condenser-tube plates, but the following simple method is most satisfactory:

The workman takes a handful of packing and standing or sitting in front of the condenser he pushes one end of a string into the annular space around the end of each tube by means of a small iron instrument, leaving the remainder of the string hanging down the face of the tube plate.

After inserting a good number of strings in this manner, he then takes a piece of brass pipe, about one foot long, having at one end a longitudinal slot sawed into it for a short distance on one side. Through this pipe he threads one of the strings of packing, the notched end of the pipe being held toward the tube plate. Then inserting the end of the pipe in the annular space around the end of the condenser tube he taps it with a wooden mallet, turning the tube through an arc of 90 or 120 degrees with his left hand between the strokes of the mallet. The method is shown in Fig. 1. In this way each layer of the lacing is packed evenly and, at the same time, not so tightly as to resist movement of the tubes. Too tight packing should be carefully avoided since it destroys the fiber of the lacing and does not secure a permanent water-tight joint. The packed tube is shown in Fig. 2. The above method takes time, but a tight joint is insured when the packing is in place.

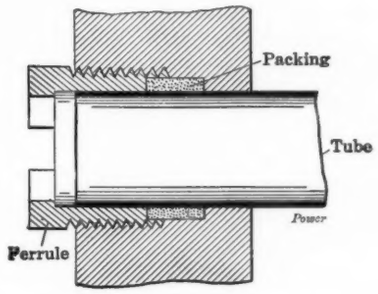


FIG. 2. DETAIL OF TUBE END

Some Types of Torsion Meter*

By Edward P. Buffet

With the advent of the steam turbine in marine practice came the necessity of measuring the power delivered to the shaft. The steam-engine indicator was not applicable to this purpose and water brakes could not be used conveniently aboard ship. This led to the development of the torsion meter, based upon the principle that the arc of torsion of a shaft is proportional to the torque applied.

Dynamometers are divided into two general classes, namely, those of absorption and those of transmission. The absorption type is substituted for the resistance against which the prime mover works, and absorbs in friction or otherwise the power generated; the prony brake belongs to this class. Transmission dynamometers, on the other hand, are inserted somewhere between the source of power and the point at which it is utilized; consequently they may often be employed for taking measurements while the engine is in service. To this class belongs the special type known as torsion meters.

These meters are especially adapted to measuring the torsion in the shaft which transmits the power. While the original of this type dates back many years to the "pandynamometer" of Hirn, yet the development in general practice is comparatively recent and is the outcome of a need created by the steam turbine. With the advent of this type of engine, there arose a difficulty in accurately determining its power, as the reciprocating-engine indicator was not adapted to this use. In marine practice, efficiency measurements of the turbine and propeller often had to be lumped together, which was very unsatisfactory. This set engineers to work upon devising improved methods of applying the simple principle that a shaft when transmitting power will undergo a twisting action, which bears a definite relation to the power that is being transmitted. If we lay off a certain length upon the shaft, limited by two points in the same plane, and can devise some method of measuring the angular displacement of one point with reference to the other, while the shaft is transmitting power, this displacement, due to the twisting of the shaft, will be a function of the power transmitted. We shall not here concern ourselves with the mathematical calculations necessary to figure this out, further than to state the rule: *The amount of twist varies directly as the length between the two points, directly as the moment of the load applied, inversely as the rigidity of the material, and inversely as the fourth power of the shaft diameter.*

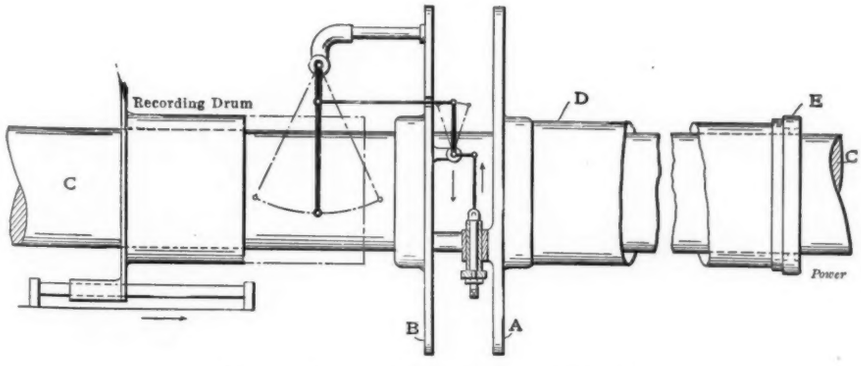


FIG. 1. FOETTINGER TORSION INDICATOR

The measurement of power by this means presents some decided advantages over the steam-engine indicator in point of reliability and the elimination of certain disturbing factors which often enter into the result. There is need, however, of care and precision in practice, since the actual amount of twisting in a shaft is usually very small; the twist of a propeller shaft, for example, rarely exceeds one degree in 10 feet of length, so that for a 12-inch shaft the circumferential displacement is only about one-eighth of an inch at full power. Yet with certain torsion meters it has been possible to determine powers to within one-fourth of one per cent., and possibly even that degree of precision has been exceeded.

A convenient division of the leading types of torsion meter can be made into three classes—mechanical, electrical and optical.

MECHANICAL TORSION METERS—THE FOETTINGER

Referring to Fig. 1, *A* and *B* are two annular disks attached to the shaft *C*; *B* directly connected to the shaft, and *A*

*Embodying material from an article in the *Revue de Mécanique* and various other sources.

serving as a flange of the sleeve *D* which extends to the right and is fixed to the shaft at *E*. Thus the length on the shaft

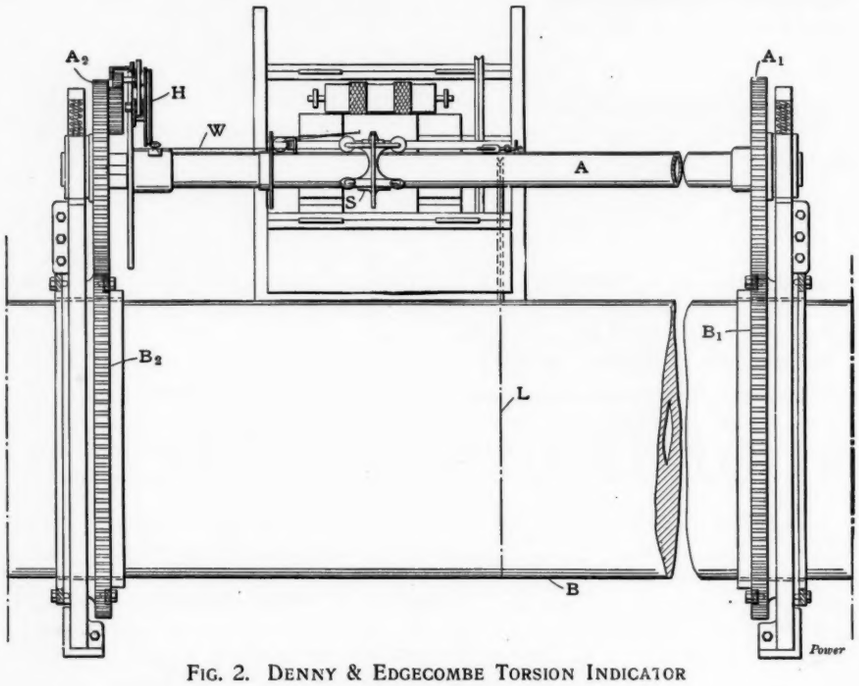


FIG. 2. DENNY & EDGECOMBE TORSION INDICATOR

availed of for torsional measurement is much greater than the distance between the two flanges themselves. A system of levers connecting these flanges amplifies their relative twist to move a pencil on an indicator drum. The illustration shows a simple form of drum consisting of a sleeve surrounding the shaft, fixed at the bottom so that it cannot revolve and arranged so that it may be slid along to the right under the pencil. As a matter of fact, a more refined sort of continuous drum is employed, this being driven by a gear from the shaft. At high speeds means are provided to compensate for the effect of centrifugal force.

Investigations with this instrument have proved that shafts driven by reciprocating engines give considerable variations in torque, very important differences existing at high speeds between the diagrams produced by the torsion meter and corresponding ones plotted from steam-engine indicator cards and inertia force.

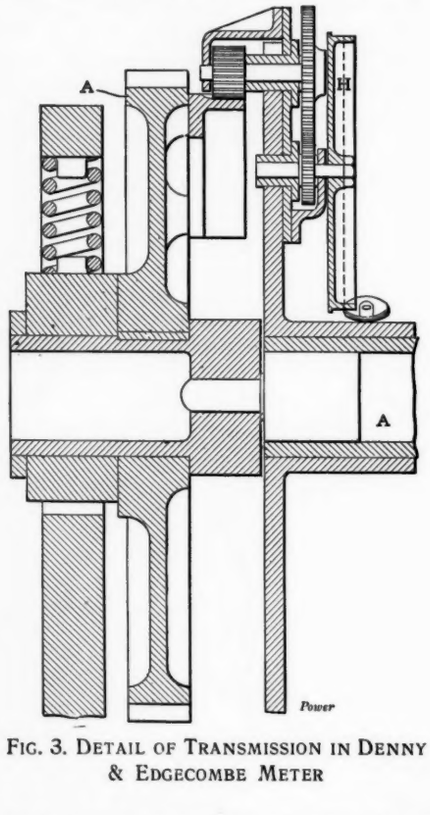
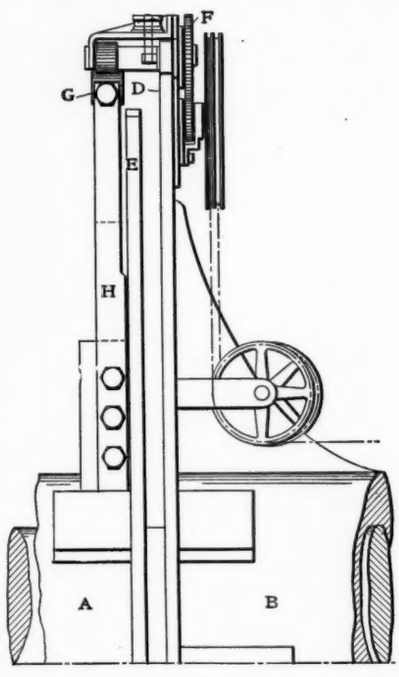


FIG. 3. DETAIL OF TRANSMISSION IN DENNY & EDGECOMBE METER



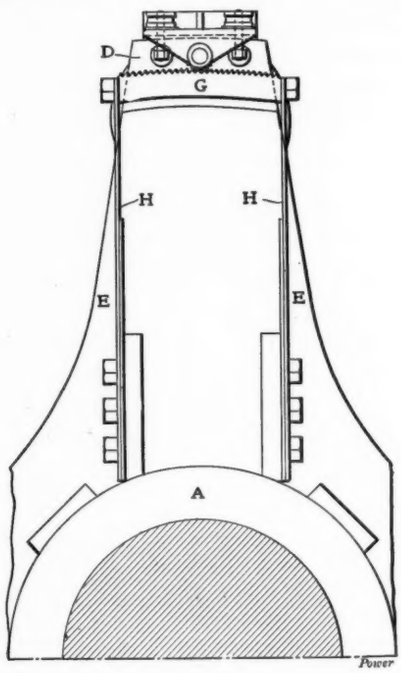


FIG. 4. DENNY & EDGECOMBE DAMPING DEVICE

THE DENNY & EDGECOMBE

In the Denny & Edgecombe torsion meter, Figs. 2 and 3, a countershaft *A* is geared parallel to the main shaft *B* and runs at an increased speed. Equal gears B_1 and B_2, fixed upon the main shaft, mesh with smaller equal gears A_1 and A_2; the former is fixed to the countershaft and the latter is free to turn upon a bushing. It is evident that gear A_2 will revolve with shaft *A* as if keyed to it, except that, when shaft *B* is twisted, gear A_2 is angularly displaced about shaft *A*, a proportionate amount. Countershaft *A* and gear A_2 are connected by a train of gearing which, when they are angularly displaced, actuates an indicator pencil. The mechanism by which this is accomplished is shown, in Fig. 3. Let it suffice to say that over a pulley *H* passes a wire *W* (Fig. 2), which runs to a saddle *S* that rolls along shaft *A* and engages with a

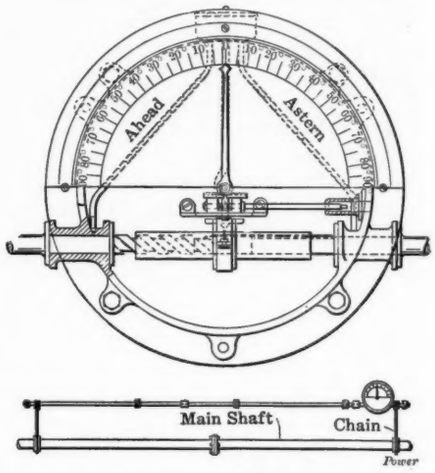


FIG. 5. THE COLLIE TORSION METER

pencil carriage. Behind this saddle is fixed the continuous record sheet which is fed from the main shaft by a belt shown by the broken line *L*. There is a second pencil to trace the base line of the diagram.

Evidently the saddle and entire mechanism controlling it rotate constantly with countershaft *A*, but the pencil and drum

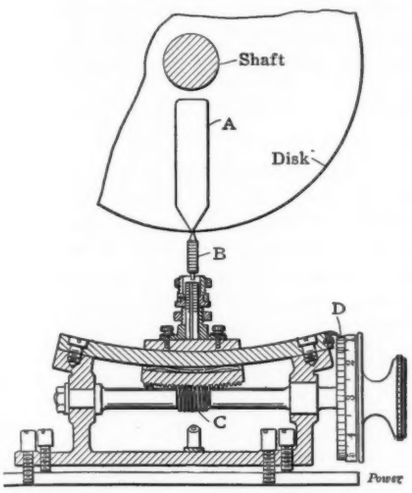


FIG. 6. DENNY & JOHNSON TORSION METER

mechanism are fixed. The edge of the saddle disk *S*, which does revolve, engages with a jaw on the pencil carriage which also does not revolve. Another feature of this meter is the spring devices for absorbing the backlash of the gears.

Fig. 4 shows a damping device brought out in 1908 by Denny & Edgecombe, by which the effect of violent fluctuations of torque that might endanger the apparatus is taken up by springs. It is applicable to the countershaft type of torsion meter already described, but as here shown is adapted to a pattern by which is measured the relative movement between adjacent ends of sleeves attached to the shaft some distance apart. The arc-shaped gear *G* actuates the multiplying gear *F*, mounted upon arm *D* at the inner end of the sleeve *B*, and, instead of being rigidly mounted, is carried by two springs *H* fixed to brackets upon arm *E* at the adjacent end of the other sleeve *A*. Under abnormal stress the springs *H* yield. When the torsion meter is used in connection with shafts not subjected to a fluctuating torque, such as those of turbines and electric motors, the gear segment may be rigidly connected to the arm *E* by means of a block fitting between the springs *H*, and secured to the arm.

THE COLLIE

In the Collie type, Fig. 5, the rotation of the shaft is transmitted by chain belts to a smaller shaft consisting of two parts, one of which screws into the other. According to the amount of torsion of the main shaft between the two pulleys, the two portions of the small shaft are screwed together, which relative position controls the movement of a needle on a dial.

ELECTRICAL TORSION METERS—DENNY & JOHNSON

The first electrical torsion meter devised by Mr. Denny was a simple affair and consisted of two insulating disks placed at some distance apart on the shaft; each of these carried a point touching a brush and, when unloaded, thus completed an electric circuit, at a certain point in the shaft revolution. The circuit passed through a telephone receiver which gave a click, but no current was produced unless both brushes touched simultaneously. When the shaft was loaded its torsion threw the points out, so that they did not touch at the same time. Then one of the stationary brushes

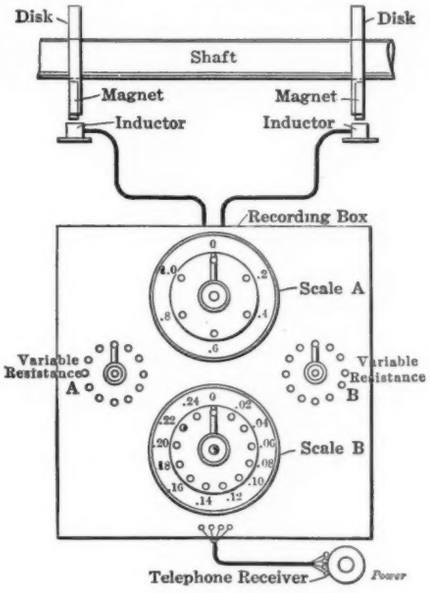


FIG. 7. DENNY & JOHNSON'S IMPROVED TORSION METER

had to be moved through an arc about the shaft a sufficient amount to restore concordance, which amount was measured on the shaft by a micrometer screw. This gave the angle of twist from which the power could be calculated.

This apparatus worked fairly well for slowly revolving shafts, but for high speeds a better form of contact became necessary. This problem was solved by Mr. Johnson and is shown in Fig. 6. The points on the shaft were replaced by chisel-shaped permanent magnets *A* and the stationary brushes by corresponding chisel-shaped electromagnets *B*. The electromagnets were connected with a differentially wound telephone receiver and at the instant the permanent magnets passed over them, currents were generated in the electromagnets and sent through the telephone. If these currents were simultaneous, being equal and opposite, the telephone gave no sound. If, by reason of the twisting of the shaft, they were produced at different times, they became audible in the receiver. The position of one of the electromagnets could then be slightly changed by the gear *C*, until the telephone recorded no sound. The amount of shifting denoted the degree of torsion and was measured by the micrometer *D*.

While this arrangement worked very well, it required the operator to be in the noisy tunnel of the ship. To overcome this, Mr. Johnson designed another arrangement shown in Fig. 7. The permanent magnets were retained but the chisel-shaped electromagnets were replaced by two soft-iron sector cores, or inductors; one contains six insulated coils spaced 0.2 inch apart, and the other has thirteen insulated coils spaced 0.02 inch apart. Below these is the recording box, which contains two disks fitted with contact studs and movable contact arms. The upper one, marked scale *A*, is connected with the inductor nearest the propeller and has six contacts to correspond with the six coils on the inductor, that are spaced 0.2 inch apart. The other one, marked scale *B*, has 13 contact studs, connected to the 13 coils spaced 0.02 inch apart on the other inductor, these contact studs being devices for switching any desired coil into the telephone circuit. On the recording box there are also two side coils, marked respectively resistance *A* and resistance *B*. These are for throwing resistance into series with the differential windings of the telephone receiver, which is connected to the two inductor circuits, and their circuits must be accurately balanced

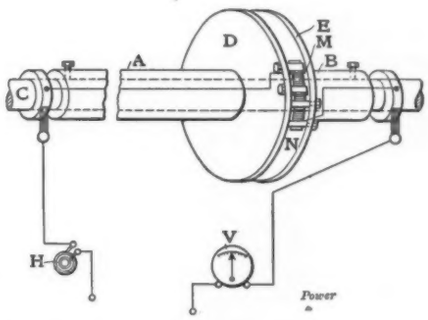


FIG. 8. NEW TYPE OF DENNY & JOHNSON METER

before absolute silence can be obtained in the receiver.

To take a reading after the instrument has been set, and the resistance of the two telephone circuits has been adjusted by means of the variable resistances, it is necessary only to turn the arm on scale *B* around to the various studs until there is silence in the telephone, when the amount of torsion is immediately read on the scale. If no such position be found, it means that the shaft is being twisted more than is covered by the scale; the arm on scale *A* is then turned to the first contact, and the arm on *B*

is again swept round the circuits. If silence be still not obtained, the arm on *A* is turned to the second contact, and so on, the combined range of the scales being 1.24 inches, which is more than sufficient to measure the maximum twist usually obtained. The object of this is

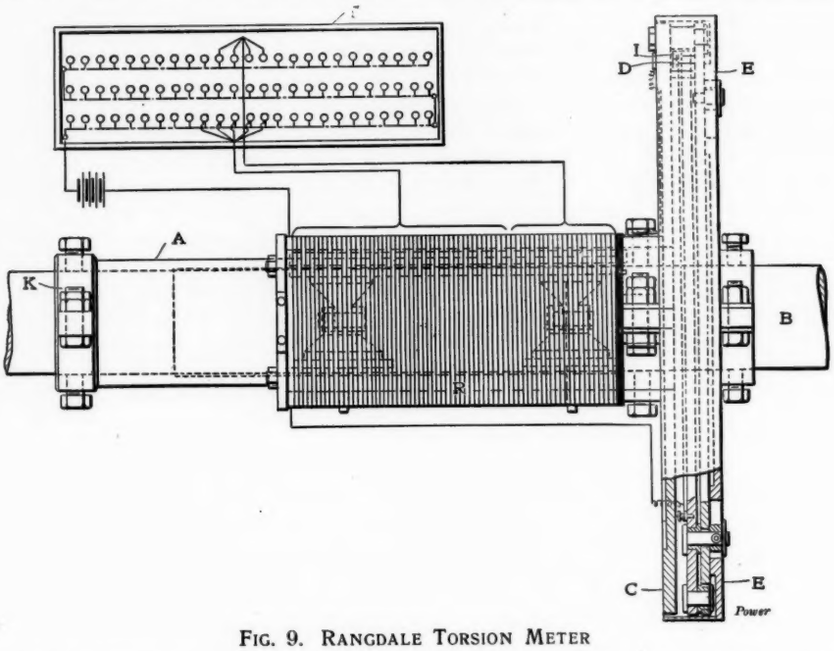


FIG. 9. RANGDALE TORSION METER

to throw in those coils that will be passing under the centers of the two permanent magnets simultaneously. The change from one to another coil of the coarsely wound electromagnet serves for coarse adjustments while the subsequent fine adjustments are made with the finely wound magnet. From torsional experiments on the shaft, made previous to the meter being fitted in the ship, or from a predetermined formula, the factor by which this reading is to be multiplied is obtained, and the power is easily calculated.

A patent has been granted this year for another Denny & Johnson electrical torsion meter, quite different from the foregoing. Fig. 8 shows two sleeves *A* and *B*, attached at their outer ends to the shaft *C*, the torsion in which is to be measured. At the near ends of these sleeves are disks *D* and *E*, upon which are electromagnets *M* and *N*, with their pole faces adjacent. One end of the winding of the magnet *M* is connected with an alternator *H*, the opposite pole of which is grounded. The other end of the winding of the magnet *M* is grounded to a stud on disk *E*. One end of the winding of the magnet *N* is connected with a voltmeter *V*, the other terminal of which is grounded. The other end of the winding of the magnet *N* is grounded to the stud on the disk *E*. The alternator *H* is driven from the shaft *C* and supplies current to the electromagnet *M*. This current gives rise to a magnetic field, which in turn induces a current in the windings of electromagnet *N*. The current supplied by the alternator varies with the speed of the shaft, and the induced current in the windings of *N* depends upon the strength of this current and the air gap between the electromagnets *M* and *N*. This air gap varies with the torque to which the shaft is subjected. By suitably calibrating the voltmeter *V* the torque or horsepower can be read directly.

THE RANGDALE

A torsion meter whose indications appear through a series of electric lamps has been patented by George Stuart Rangdale and the Palmers Shipbuilding and Iron Company of England.

Referring to Fig. 9, sleeve *A* is fixed on the shaft *B* at *K*, and at the other end is carried a flange *C*, turning opposite to a wheel *E* which is fixed upon the shaft. Between the flange and the wheel is a set of levers by which is obtained a movement multiplying their relative angular displacements due to the twisting of the shaft.

This amplified motion is employed to move the brush *I* over an arc-shaped commutator *D*, placed between the wheel and the flange. The strips of this commutator are connected with a series of insulated collector rings *R* situated around the sleeve; and each of these is provided with a brush which places it in circuit with a lamp on the table *T*. The current is furnished by a battery. The contacts in commutator *D* are arranged in order with the lamps, so that the latter are lighted in regular succession according to the angle through which the shaft is twisted. The arrangement is double-acting, indicating movements of the vessel both ahead and astern. The commutator brush is sufficiently broad so that each lamp is extinguished only after the next one has been lighted.

THE GARDNER

In the Gardner device there are mounted upon the shaft two similar collectors, with brushes connecting them to the circuit of a galvanometer. When the shaft is not under torque, the position of the brush on the segments of one collector corresponds to that of the brush on the insulated sections of the other collector and no current passes. When the shaft is twisted, a circuit is completed, and increases directly with the torque.

OPTICAL TORSION METERS—THE BEVIS-GIBSON

Reference has already been made to the use of a ray of light for indicating purposes in torsion meters. A recent application of this principle is found in the Bevis-Gibson flash-light torsion meter, a device capable of high precision. At a distance apart on the shaft are mounted two disks, each pierced near its periphery by a small radial slot, both slots being in the same plane when no torque is exerted on the shaft. Behind one slot is placed a light and in front of the other an eye piece, called a "torque finder." When the shaft is transmitting no power, the two slots, the light and the eye piece are all in line and, at a certain point of each revolution, the observer perceives through the eye piece a flash of light. If the shaft is turning at a speed of 100 revolutions per minute or more, this flash will appear to be continuous. If, however, a load be applied, the torsion of the

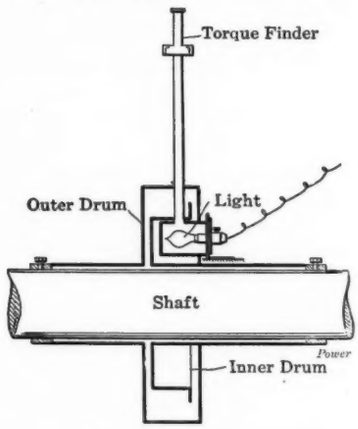


FIG. 10. TYPE OF METER USED WHEN ONLY SHORT LENGTH OF SHAFT IS AVAILABLE

shaft will throw the slots out of line so that there is complete darkness all the time. If, now, we move the eye piece a little to one side, we can bring it again in line with the slots and lamp, looking obliquely, and can restore the flash.

The angle through which the eye piece is shifted is measured by a micrometer and the torsion determined accordingly. One advantage of this type is that the disks can be fitted a greater distance apart and closer readings thus obtained.

For reciprocating engines a simple modification of the flash-light torsion

meter enables the operator to take several readings in one revolution of the shaft. The disks are perforated with 12 slots arranged in the form of a spiral—and spaced 30 degrees apart. The lamp and the torque finder are moved radially from the shaft so as to bring them into line with each corresponding pair of slots in the disk.

Cases sometimes occur, especially in modern warships, where a long length of shafting is not available for torsion-meter purposes, and recourse may then be had to a special form of apparatus. This is shown in Fig. 10. The perforated disks are here replaced by concentric drums around the shaft, which are slotted in their circumferences and inside the smaller of which the lamp is placed. The beam of light therefore is directed toward the torque finder in an approximately radial direction instead of one nearly parallel to the axis. It is evident that the points on the shaft to which the flanges of these respective drums are attached limit the length whose twist is measured.

The extreme sensitiveness of the apparatus is almost incredible. The angle of the flash proceeding radially from the shaft can be measured to 0.001 of a degree, so that although only 3 feet of shafting may be available, the result is as good as if a 30-foot length had been used with an axial-ray apparatus.

The Hopkinson-Thring Meter

At a recent meeting of the British Institute of Naval Architects, Professor Hopkinson described the Hopkinson-Thring type of torsion meter as manufactured by Siemens Brothers. In principle it depends upon the reflection of light from a pivoted mirror somewhat similar to the manner of taking galvanometer readings. Referring to Fig. 11, a sleeve is clamped on the shaft in the plane *A A*, and under it a collar is clamped in the plane *B B*. The operation depends upon the mutual rotary displacements of the sleeve and collar where they overlap. By an appropriate leverage system, shown in detail at *E*, a mirror pivoted in a plane of the shaft axis is caused to rotate out of this plane, about an axis radial to the shaft, when the twisting of the shaft causes a change in the relative positions of the sleeve and collar. Assuming the shaft to be running under no load and a lamp to be placed at *J* behind a scale in a line perpendicular to the center of the mirror, its ray will be reflected back to the same point for an instant each time the shaft turns around. When a load is applied, the twisting of the mirror throws the ray to a point *K*, at one side of *J* on the scale, its angular reflection bearing a definite relation to the torsion of the shaft. In practice, usually two or more mirrors are employed, they being placed on opposite sides of the sleeve. The rays of light reflected on the scale are, of course, mere flashes, but at high speeds they appear continuous. In certain ways it is possible to distinguish the reflections of the different mirrors. As their readings may be expected to disagree slightly, a mean of them is taken.

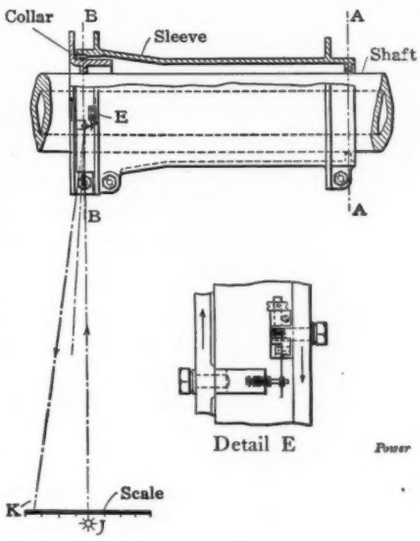


FIG. 11. HOPKINSON-THRING TYPE OF TORSION METER

Increasing the Power of an Engine

The work of an engine is expressed by the formula

$$P \times L \times A \times N = Work$$

in which

P = Unbalanced pressure per square inch on the piston.

L = Length of the stroke of the piston in feet.

A = Area of the piston.

N = Number of strokes per minute.

In other words, the work performed in a minute is the product of the pressure acting and the space through which it acts in that time. The product of P and A is the pressure and the product of L and N is the space.

If numerical values be given to the letters in the left-hand member of the equation, a definite number will appear at the right.

If any of the factors be increased in value the work will be increased in the same proportion and a decrease in work will result from a decrease in the value of any one or all of these factors.

What has just been said was prompted by a correspondent who says that this question was put to him during a recent examination for an engineer's license:

Suppose you were running an engine at full capacity, the limit of flywheel speed had been reached, you did not wish to compound, did not wish to bore out the cylinder, could not put on two eccentrics, could not raise the steam pressure, could not make the cutoff later nor run condensing, what would you do in order to carry more load?

If, as stated in the question, none of the factors that go to make up the power of the engine can be increased, no more load can be carried.

But there is an implication in the question that some change may be made that will enable the engine to carry a heavier load and suggestions may be sought for in the question itself.

First, limit for flywheel speed is reached.

The speed of the engine may be safely increased by putting a smaller flywheel on the shaft, increasing the factor N in the equation and thus increasing the power. Compounding, boring to a larger diameter and an extra eccentric being forbidden, they are passed and the question of steam pressure taken up.

Steam pressure at the boiler may not be increased, but the drop in pressure between the engine and the cylinder may possibly be reduced by suitable changes in size and arrangement of piping, and the installation of a steam drum or reservoir close to the cylinder. This, though not increasing the steam pressure at the boiler, may permit a higher pressure to be realized in the cylinder.

It may be found that there is more inside lap of valve than is necessary and that a reduction will produce an earlier opening and a later closure of the exhaust port, thus reducing the back pressure on the piston.

Doing either of these things would be tantamount to an increase of the factor P in the equation and a consequent increase in power would follow.

And, lastly, "cannot run condensing."

Condensers are installed with steam engines for the sole purpose of reducing the back pressure. In the case stated a condenser is tabooed, but an examination of the exhaust passage and piping may show that the back pressure on the piston may be reduced, which is as beneficial as a raise in the initial pressure, and produces results equivalent to an increase in the factor P in the equation.

It would appear from an examination of the question that with an ordinary case where especial attention had not been given steam- and exhaust-pipe sizes, and to valve design and setting, the factors P and N in the horsepower formula might both be increased with consequent increase in power and still be within the restrictions stated in the question.

Electrical Department

Primer of Electricity

RESISTANCE LOSS IN A DYNAMO ARMATURE

It was explained in one of the early Primer lessons that passing a current through any conductor requires power to be spent, and the loss of power is manifested by heating of the conductor. Thus, if 10 amperes are passed through a conductor which has a resistance of 25 ohms, it requires a pressure of

$$10 \times 25 = 250$$

volts to force the current through; this is called "drop," meaning loss of pressure, and the power spent in forcing the current through is equal to the "drop" multiplied by the current, thus:

Drop in volts $\times$ *Amperes* = *Watts*

lost in overcoming the resistance. Since the drop is equal to

Resistance $\times$ *Current,*

the power lost by resistance is equal to

Ohms $\times$ *Amperes* $\times$ *Amperes;*

or

Ohms $\times$ *Amperes*^{2} = *Watts* lost.

From the foregoing it follows that when current passes through the armature winding of a dynamo or motor, there results a loss of power proportional to the resistance of the winding and the square of the current passing through it. The armature windings of all direct-current machines have at least two parallel paths through them, as explained in the Primer lesson of January 25, and many windings have more than two. For this reason, the resistance of the winding as a whole is much less than it would be if the wire in the winding were arranged in a single path; that is, all in series. This is a question of the joint resistance of parallel circuits, which was explained in detail in the lesson of October 19, last year

Suppose, for example, that an armature winding contained 80 coils of No. 13 wire, each coil containing 10 turns and each turn being 15 inches long. Each coil would contain

$$150 \div 12 = 12\frac{1}{2}$$

feet of wire and the whole winding would contain

$$12\frac{1}{2} \times 80 = 1000$$

feet. The resistance of the wire, if it were all in one piece, would be about 2.4 ohms when warmed up. But if the winding were divided into two parallel paths, each path would contain one-half of the wire and the resistance of each half would therefore be 1.2 ohms; the two halves in parallel would have a resistance of

$$1.2 \div 2 = 0.6 \text{ ohm.}$$

Now, if the full-load current of that armature were 30 amperes, the drop in it would be

$$0.6 \times 30 = 18 \text{ volts,}$$

and the loss of power due to the resistance of the winding would be

$$18 \times 30 = 540 \text{ watts.}$$

Ignoring the drop and figuring the loss from the resistance and current directly:

$$0.6 \times 30^2 = 0.6 \times 900 = 540 \text{ watts.}$$

This can be proved by considering the paths in the winding separately. If the total armature current were 30 amperes and there were two parallel paths, each path would carry 15 amperes. As just shown, the resistance of each path would be 1.2 ohms; consequently the watts lost in each path would be

$$1.2 \times 15^2 = 1.2 \times 225 = 270$$

watts, and the loss in the two paths would be twice this, or 540 watts, as obtained by the first calculation.

Now suppose this same armature winding were arranged to have four parallel paths. The total resistance of the wire being 2.4 ohms, the resistance of each path would be one-fourth of that, or 0.6 ohm, and the joint resistance of the four paths in parallel would be one-fourth of the resistance of each one separately, or 0.15 ohm. The watts lost in this winding would be equal to 0.15 $\times$ the square of the total current.

From what has been said it will be clear that

The resistance of any armature winding is equal to the total series resistance of all the wire in it divided by the square of the number of parallel paths through the winding.

Thus, with two paths, the total series resistance is divided by four; with four paths, by sixteen; with six paths, by thirty-six, and so on. (An armature winding having more than one path through it cannot have an odd number of paths.)

Table 5 is very useful for estimating the resistance of armature windings with-

Especially conducted to be of interest and service to the men in charge of the electrical equipment.

TABLE 5. RESISTANCE OF ARMATURE WINDINGS WHEN WARM.

Effective resistance of the winding per foot of wire in it.

The resistances given in the upper half of the table are 1,000,000 times as great as the actual resistances, in order to avoid the use of a large number of decimal places. Consequently, final results obtained from this part of the table must be divided by 1,000,000.

Wire Gage Sizes.	2 Paths.	4 Paths.	6 Paths.	8 Paths.	10 Paths.	12 Paths.	16 Paths.
4	74	18.5	8.2	4.62	3.00	2.05	1.15
5	93	23.4	10.4	5.84	3.74	2.60	1.45
6	117	29.4	13.0	7.35	4.70	3.25	1.85
7	148	37.0	16.5	9.28	5.94	4.15	2.35
8	187	46.8	20.8	11.7	7.50	5.20	2.93
9	236	59.0	26.2	14.7	9.5	6.55	3.68
10	298	74.4	33.1	18.6	11.9	8.25	4.65
11	375	93.8	41.7	23.4	15.0	10.4	5.85
12	473	118	52.6	29.5	18.9	13.1	7.4
13	597	149	66.3	37.3	23.9	16.5	9.3
14	752	188	83.6	47.0	30.1	20.9	11.7
15	949	237	105	59.3	37.9	26.3	14.8
16	1,190	299	133	74.7	47.8	33.2	18.7
17	1,500	377	167	94.3	60.3	41.9	23.5
18	1,900	475	211	119	76	52.8	29.7

The resistances in the lower half are 10,000 times the actual resistances.

19	24.0	6.0	2.66	1.50			
20	30.2	7.56	3.36	1.89			
21	38.1	9.53	4.23	2.38			
22	48.1	12.0	5.35	3.01			
23	60.6	15.0	6.74	3.79			
24	76.5	19.1	8.5	4.78			
25	96.4	24.1	10.7	6.02			
26	121	30.4	13.5	7.60			
27	153	38.3	17.0	9.58			
28	193	48.3	21.4	12.08			
29	243	60.9	27.1	15.2			
30	307	76.8	34.1	19.2			
31	387	96.9	43.0	24.2			
32	488	122	54.3	30.5			
33	616	154	68.5	38.5			
34	777	194	86.4	48.6			
35	980	245	108.5	61.2			
36	1,236	309	137	77.2			

out figuring the total resistance of the wire and then reducing it to the effective resistance for the number of paths through the winding. In order to avoid using a large number of decimal places, the resistance values in the upper half of the table have been made 1,000,000 times the actual effective resistance of the winding per foot of wire in it, and the values in the lower half are 10,000 times the actual effective resistances. To use the table, it is necessary only to multiply the total number of feet of wire by the number in that column of the table under the number of paths in the winding; then divide by 1,000,000 if the number is in the upper half or by 10,000 if it is in the lower half of the table. For example, suppose a winding contains 850 feet of No. 10 wire and has eight paths through it. Starting at the number 10 in the column of wire sizes, follow that line into the table until the 8-path column is reached; here will be found the number 18.6. Multiplying this by the number of feet gives

$$850 \times 18.6 = 15{,}810,$$

and dividing this by 1,000,000 gives 0.01581, or practically 0.016 ohm, as the resistance of the winding.

Again, suppose a four-path armature contains 600 feet of No. 16 wire. In the upper half of the table, in line with No. 16 and in the 4-path column is the number 299. Multiplying this by 600 gives 179,400, and dividing this by 1,000,000 gives 0.1794 or practically 0.18 ohm, as the resistance of the winding.

Once more, if a bipolar winding (two paths) contains 250 feet of No. 23 wire, what will be the resistance when warm? In the No. 23 line and the 2-path column is the number 60.6, and as this is in the lower section of the table it must be divided by 10,000 giving 0.00606 for the constant. Multiplying this by 250 gives 1.515 ohms as the resistance of the winding.

As the values in the table are based on the hot resistance of the wire, and the temperature of the actual winding may be appreciably different from that for which these figures are calculated, it is not worth while to split hairs in the final results; three figures are sufficient, and if the third figure is as small as 2, it may as well be dropped. In the last example therefore, it would be amply accurate to say that the resistance would be substantially 1.5 ohms.

It must not be forgotten that the result of each calculation is the resistance of the armature winding as a whole, that is, the resistance that would be obtained if it were measured between the positive and negative brushes of the armature and the resistance of the brushes themselves deducted. The loss in the winding is ascertained in watts by multiplying the resistance by the square of the total current, as in the foregoing examples. Thus, if the total current of the eight-path armature wound with No. 10 wire were 150 amperes, the loss in the winding would be

$$150^2 \times 0.016 = 360$$

watts. If the current in the four-path winding of No. 16 wire were 20 amperes, the loss in the winding would be

$$20^2 \times 0.18 = 72$$

watts. And if the total current of the two-path armature wound with No. 23 wire were 2.5 amperes, the loss would be

$$2.5^2 \times 1.5 = 9.375,$$

or practically 9.4 watts.

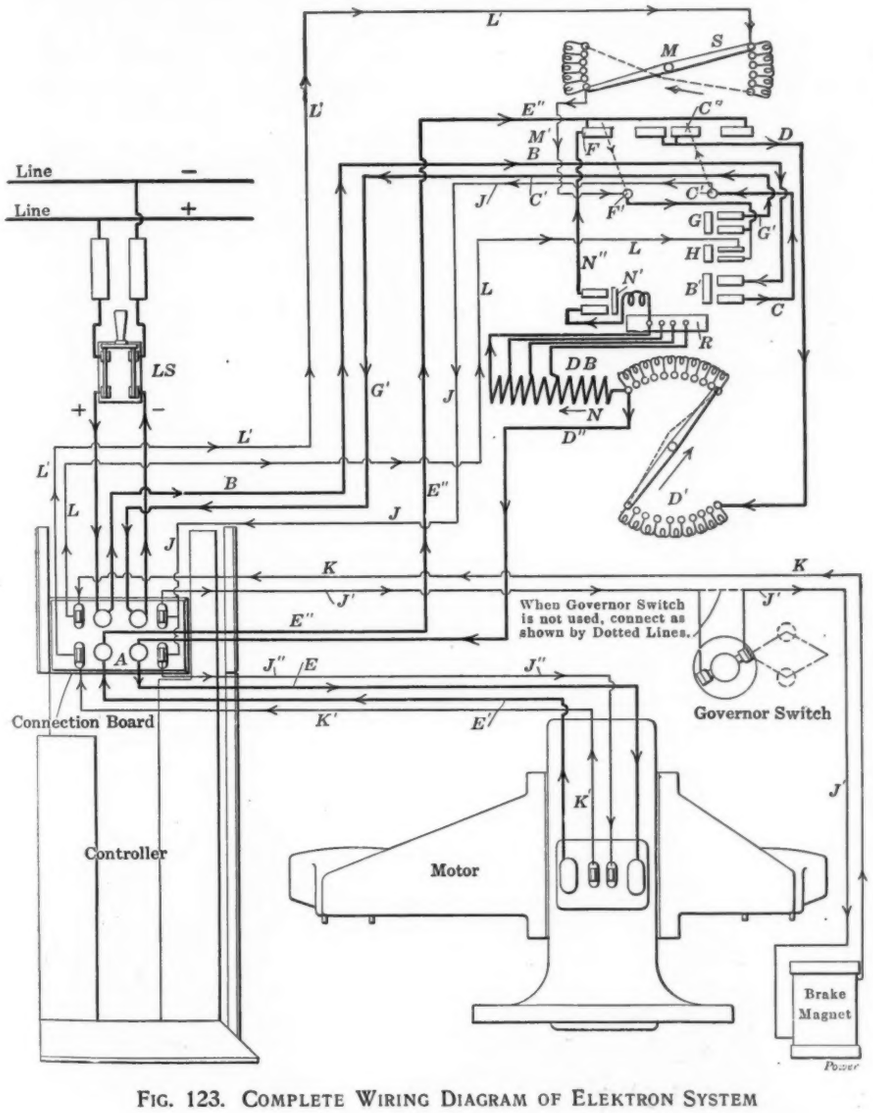


FIG. 123. COMPLETE WIRING DIAGRAM OF ELEKTRON SYSTEM

The Electric Elevator

BY WM. BAXTER, JR.

THE ELEKTRON SYSTEM

(Concluded)

The complete wiring diagram of the Elektron controller is shown in Fig. 123. This diagram is very complete; it shows not only all the wire connections between the motor, the controller and the line, but also the connections with the connection-board binding posts on the controller box. Such a diagram serves admirably to enable one to trace out the internal connections of the controller starting from the binding posts and running to the several internal points, but the introduction of the controller connection board complicates the appearance of the diagram; for this reason the simplified diagram, Fig. 124, is presented, by the aid of which Fig. 123 can readily be analyzed. The only difference between these two diagrams is that in the latter the connections between the controller and the motor are shown direct instead of passing through the connection board on the side of the controller box. The direction of the current through each of the wires of the system is indicated by an arrow head, so that an extended explanation will not be necessary; by starting from the + line and following the arrow heads, the path of the current can be traced. The parts marked *C"* and *F* are the stationary contacts of the reversing switch which was explained in connection with Fig. 117, and *R S* and *R S'*

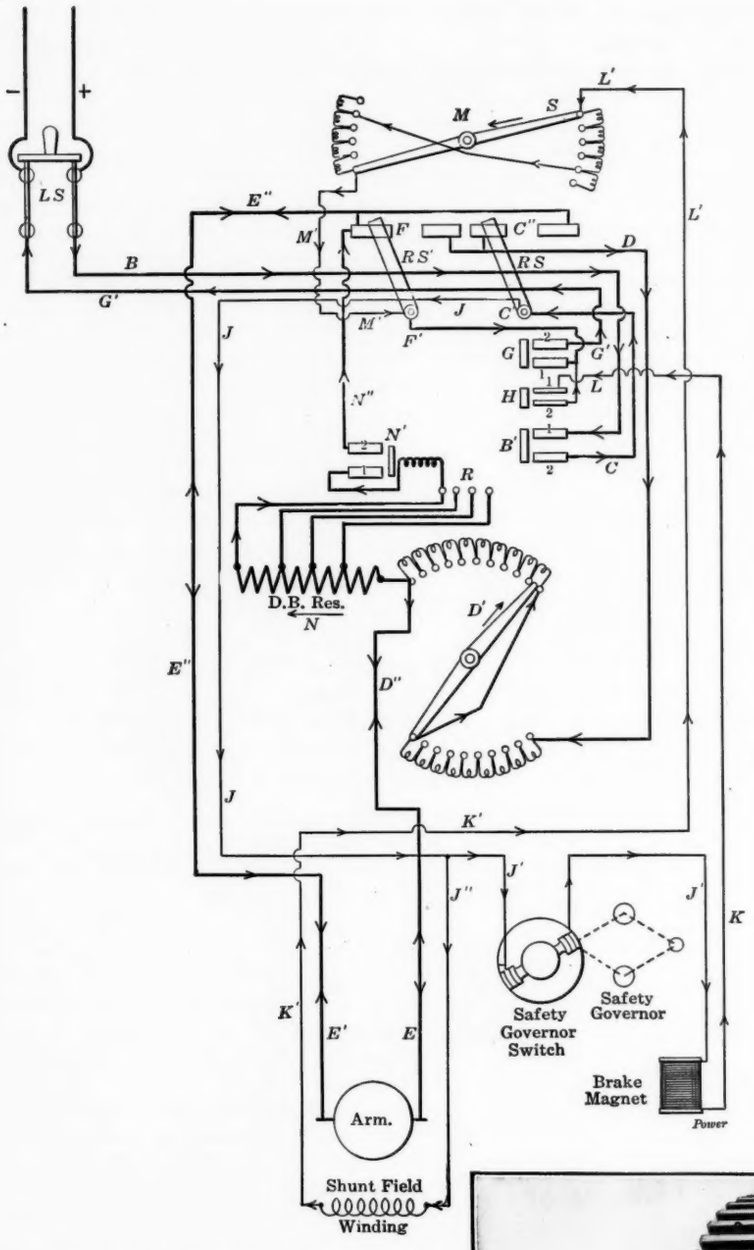


FIG. 124. SIMPLIFIED DIAGRAM

are the switch levers *A A'*. The rectangles *G*, *H* and *B'* indicate the disks of the starting switch shown in Figs. 118 and 119 and marked "Line Disks" and *J"*. The latter is marked *H* in the winding diagram, and acts to make and break the circuit of the brake magnet. The switch indicated at *N'* in the winding diagram is the dynamic brake switch shown in Figs. 118 and 119 at *G*, *G'* and *G"*.

The safety governor shown in the diagrams is a device that is commonly used with electric elevators; its object is to stop the motor if for any reason the elevator car attains a dangerously high velocity. The way in which this governor acts is indicated in the diagram. If the speed goes beyond the point for which the apparatus is adjusted, the switch controlled by the governor is opened, and in this system it acts to open the circuit of the brake magnet so that the brake may be applied to stop the motor. In some systems the governor actuates not only a switch to open the brake magnet circuit, but also another switch to open the main line connections. The arrangement shown in the diagram will accomplish the same result although in a round-about way. If the brake is applied the motor speed will be reduced and as a result the current passing through it will be increased and will melt the safety fuse, or open the circuit breaker if one is provided, and thus the line will be opened.

The Elektron elevator machine shown in Fig. 114 is a regular type of machine used for freight or passenger service, but sometimes special machines are required for special service, and then the design is more or less modified. Fig. 125 shows a heavy-duty machine that is so arranged that it can be made to lift heavy loads at a slow speed, or lighter ones at a correspondingly higher speed. To lift heavy loads the gears *B* and *C* are thrown into mesh, and gear *B'* is moved along the shaft *S* until it is out of gear with *C'*. To run at the high speed, lifting light loads, the gear *B* is drawn out of mesh and *B'* is thrown in. This machine is arranged for mechanical control, the operating sheave being shown at *F*, back of the stop motion, which is located within the casing *G*. The worm gear that is driven by the screw on the motor shaft is within the casing *A* and is mounted on the shaft *S*, so that the drum is driven indirectly through one or the other of the gears *B*, *B'*, both being made to slide along the shaft, a feather being provided to make them revolve with the shaft.

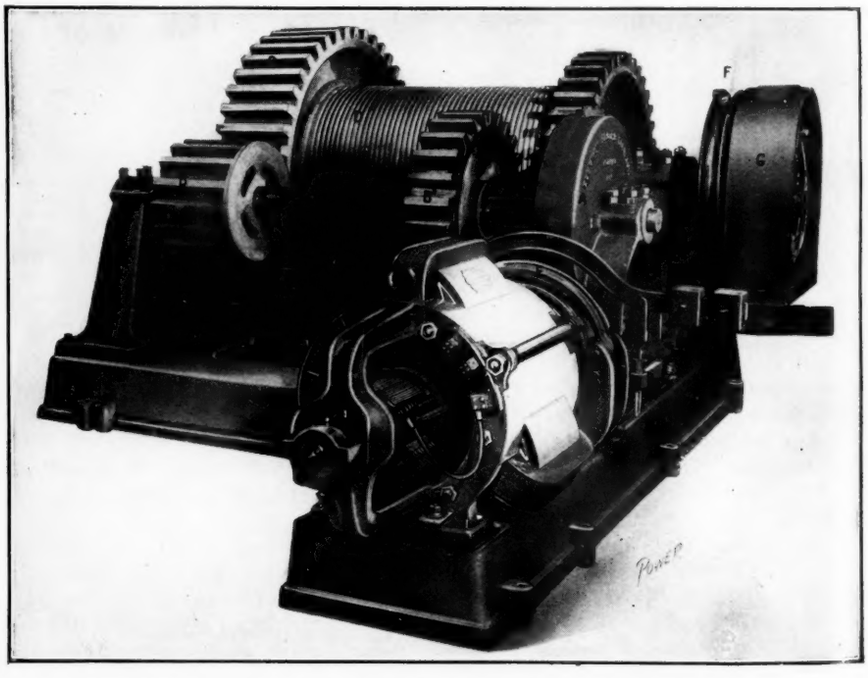


FIG. 125. ELEKTRON BACK-GEARED ELEVATOR MACHINE

LETTERS

Kerosene Oil for Chattering Carbon Brushes

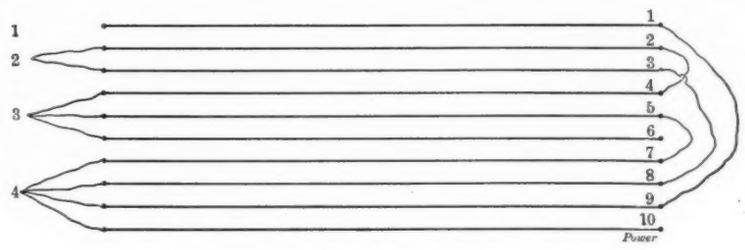
About eight or nine months ago the commutator on a multipolar direct-current machine ran dirty, with a great deal of sparking, chattering and singing of the brushes. After trying the usual remedies in regard to the setting of the brushes, sandpapering the commutator, etc., without much improvement, I was advised to soak the brushes in kerosene oil, but first to try squirting kerosene on them while running. This latter experiment had a good effect and did not cause short-circuiting, as I was afraid it would. The next day I soaked two sets of the brushes for one-half an hour in kerosene, with decided benefit; the day after, two more sets were soaked, and the following day the remaining two sets. As a result, the singing and chattering disappeared, there was a minimum of sparking, and a fine brown gloss appeared. I soaked the brushes again, about two months later, and ever since then the commutator has run smoothly, there is no noise and no sparking. Of course, after soaking the brushes in oil they should be wiped dry before using them.

Brooklyn, N. Y. H. A. HUGHES.

Identifying the Conductors in a Cable

Mr. Ryan's article on locating faults in circuits, in the issue of May 24, suggested to me that perhaps a method for identifying conductors in a cable already laid, without assistance and with the least possible amount of walking, might be of service to some of the readers of POWER.

Take for example, a 10-conductor cable one-half a mile long. To identify all of the conductors by means of the galvanometer and battery by grounding one end of the conductor would call for a lot of walking back and forth. An easier method would be as follows: At the station end, connect the conductors in groups, each group containing one more wire than the preceding group. Now go to the distant end and with the galvanometer and battery identify the wires in the various groups.



IDENTIFYING THE CONDUCTORS IN A CABLE

Make a diagram similar to the one here shown. Number the conductors from one to ten and proceed somewhat as follows: Connect No. 1 to No. 9 in group No. 4; No. 2 to No. 4 in group 3; No. 3 to No. 8 in group 4, etc., taking care not to connect more than one conductor of any one group to conductors of any other one group. Indicate on the diagram the different connections and return to the station end where by means of the sketch and the galvanometer, after disconnecting the ends of the various groups, the connections as made at the distant end can be traced out and the station end numbered to correspond with the far end. For example, a wire in group 2 is connected to a wire in group 3. These can be identified and by reference to the sketch the wire in group 2 is seen to be No. 2 and the wire in group 3 is No. 4, and so on.

This method can be used on a cable with any number of conductors and dispenses with the services of an assistant and the necessary means of communication between ends. I would suggest the use of a portable voltmeter, if one is available, instead of the galvanometer.

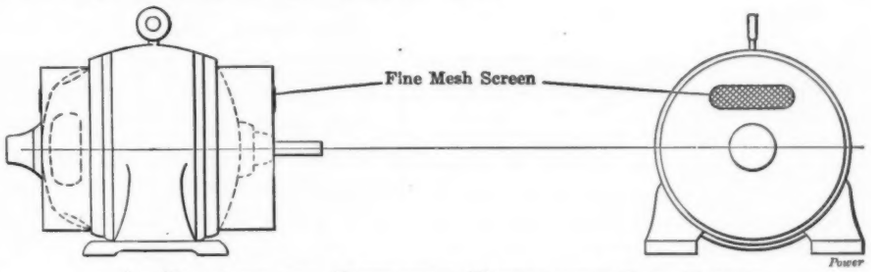
A. C. KERR.

Ft. Monroe, Va.

[This letter was printed in the July 5 number, but the diagram was accidentally omitted. Hence the repetition of the letter.—EDITOR.]

Motors in Dusty Places

Where open-type motors only are available for use in dusty places, the writer has got around the difficulty by making two galvanized-iron caps or shields fit the ends of the motor frame, each shield having an oval or oblong hole cut in it for ventilation; the hole was covered with a brass screen or bolt cloth of rather fine mesh so as to exclude the dust. The accompanying sketch illustrates this arrangement. The shield on the pulley end has to be made in two parts, unless the pulley can be taken off without too much trouble and the cap slipped on over the shaft.



AN EXPEDIENT FOR PROTECTING MOTORS WITH OPEN FRAMES

On some types of motors, some difficulty is experienced in fastening this dust shield securely, owing to construction of the frame. On most Wagner single-phase machines, however, the shields can be held on by lugs under the yoke-bolt nuts.

I have used this method very effectively on wood-mill motors, as well as on direct-current machines operating machine tools where there was a liability of metal chips or borings and oil getting into the motor and giving trouble.

A. P. H. SAUL.

Buffalo, N. Y.

[The foregoing formed part of Mr. Saul's letter on page 1206 of the July 5 number, but the illustration was unfortunately omitted. Hence the repetition of this part of the letter.—EDITOR.]

Cheating Electric Meters

The article on "Cheating Electric Meters," by Mr. Howard, in a recent issue of POWER, was of special interest to me as I used to be a meter inspector. While so employed, I came across all the "devices" mentioned, as well as several others.

One of the most common schemes is to put a "jumper" across the current coils of the meter, so as to shunt the current around the meter. This is usually done with a short piece of wire and is easily detected, as the person doing the trick will sooner or later forget to remove the wire. Another method, which can only be worked on commutator meters of the Thomson direct-current type, is to stick a hat pin between the dial glass and the case and puncture the armature winding. I caught on to this trick by finding a piece of a hat pin stuck in a meter armature.

My experience has been that very few people try to beat electric meters; and those we have detected at it have been almost all men connected with electrical work of some kind.

G. ANDERSON.

Park River, N. D.

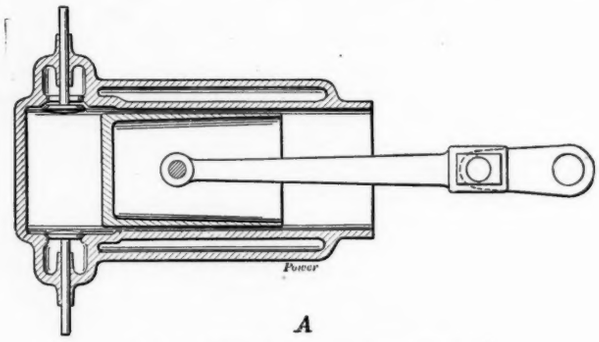
Gas Power Department

The Four Stroke Cycle*

Everything worth while in the gas engine and producer industry will be treated here in a way that can be of use to practical men.

A cycle, in engineering, is any operation or sequence of operations that leaves conditions the same at the end that they were at the beginning. To illustrate this definition, consider the case of the water evaporated in a boiler into steam, passed through the engine to do work, discharged from the engine to a condenser, and finally discharged into the stream from which it was originally taken. When the water reaches the stream it has been through a *cycle* of transformations consisting of elevation by a pump, heating to the boiling point, evaporation into steam, expansion behind the engine piston, condensation back to fluid state in the condenser, and final cooling back to its original temperature in the stream. The cycle is not complete until the last event occurs; then the condition of that water is exactly the same as before the pump lifted it from the stream. When a surface condenser is used and the condensed water is returned to the boiler through the heating system, the illustration is more exact because then the same particles of water continue to circulate through the whole system.

The engine itself affords a simpler example of cyclic operation. Consider one end of the cylinder alone; starting from the moment the admission valve starts to open, the cycle consists of steam admission, expansion and exhaust, or expulsion, which brings us back to the moment of admission again, when conditions are exactly the same as when we started. This is one cycle of steam-engine operation.



A

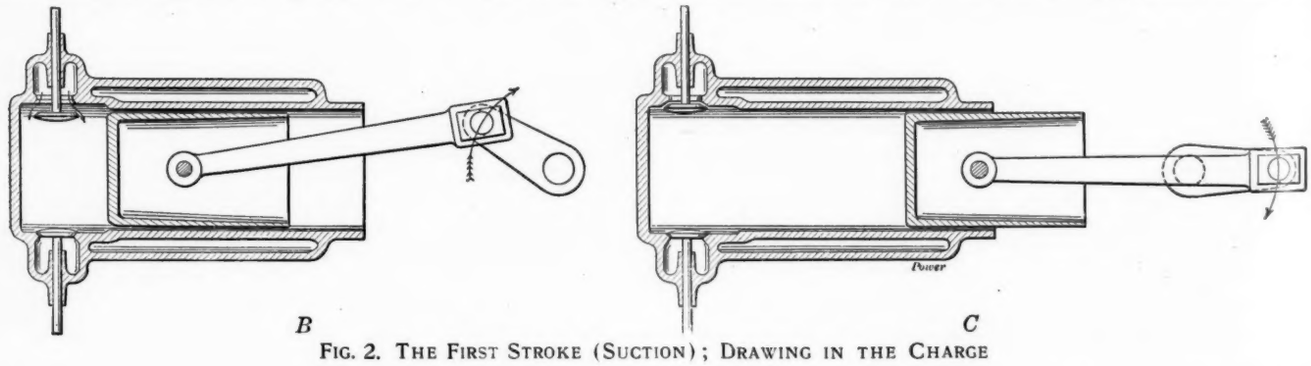
FIG. 1. BEGINNING OF THE CYCLE

The gas-engine cycle is not nearly so simple because the engine combines both pressure generation and application, whereas the steam engine has to do nothing but apply the pressure generated outside of it. The gas-engine cycle consists of admission, compression, combustion (commonly called explosion), expansion and exhaust, or expulsion. When expulsion is finished, the engine is ready to begin taking in a fresh charge, which begins the next cycle.

From a consideration of these facts, it should be plain that a so-called four-cycle engine does not perform four cycles per stroke or per revolution. One complete stroke is devoted to taking in the fresh charge, the next (return) stroke accomplishes the compression; at the end of this stroke, while the crank is passing the dead center, combustion occurs, producing the rise of pressure necessary to give power to the engine; then an outward stroke is devoted to expansion, during which the gases push the piston forward and deliver power to the crank shaft, and the succeeding stroke clears the burned gases out to make way for the next charge. To illustrate the cycle, the familiar diagrams of the four strokes, somewhat amplified, are presented herewith.

In Fig. 1 the crank is shown on the inner dead center and the inlet valve is just beginning to open to admit the charge of gas and air, which begins to be drawn into the cylinder by the suction of the piston a moment later, as represented at *B*, Fig. 2, where the inlet valve is shown wide open and the entrance of the charge is indicated by the two arrows.

While the piston moves from the position *A* to that of *C*, the charge is drawn in, and this constitutes the "suction" or admission stroke; the inlet valve is shown just about to seat, after which compression begins, as illustrated at *D*, Fig. 3. (A comparison of the piston and crank positions at *C* and *D* will show how deceptive it is to consider gas-engine events in terms of crank motion. Although at *D* the crank has moved about 19 degrees from the dead-center position, *C* the piston has moved about one-fiftieth of its stroke.)



B *C*

FIG. 2. THE FIRST STROKE (SUCTION); DRAWING IN THE CHARGE

In moving from the position represented at *D* to that at *E*, Fig. 3, the piston compresses the mixture in the cylinder, the valves remaining closed, as shown, and this is therefore termed the compression

*Although the cycles commonly used in gas engines have been explained before in these columns, letters received from regular readers during the past few months indicate that this elementary discussion will be of interest to a considerable number of subscribers. The four-stroke cycle here described is that in which combustion is assumed to be effected at "constant volume;" that is, while the piston is practically stationary.

stroke. Just before the crank reaches the inner dead center at the end of the compression stroke, the igniter operates and the rise of pressure due to combustion begins; this continues while the crank is moving over the center, from the position at *E*, Fig. 3, to that at *F*, Fig. 4, the motion of the piston during this brief period being so small as to be negligible. This completes the third event of the cycle—combustion—and the fourth event, expansion, begins.

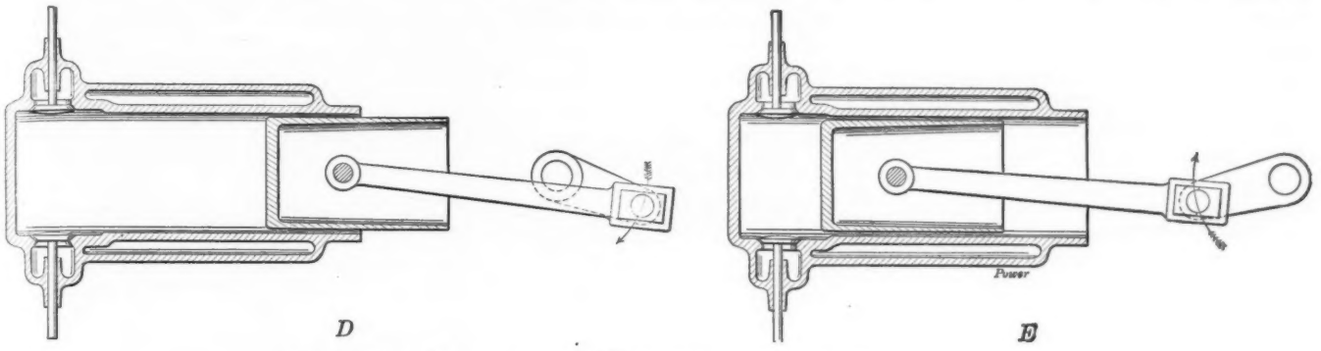


FIG. 3. THE SECOND STROKE; COMPRESSING THE CHARGE

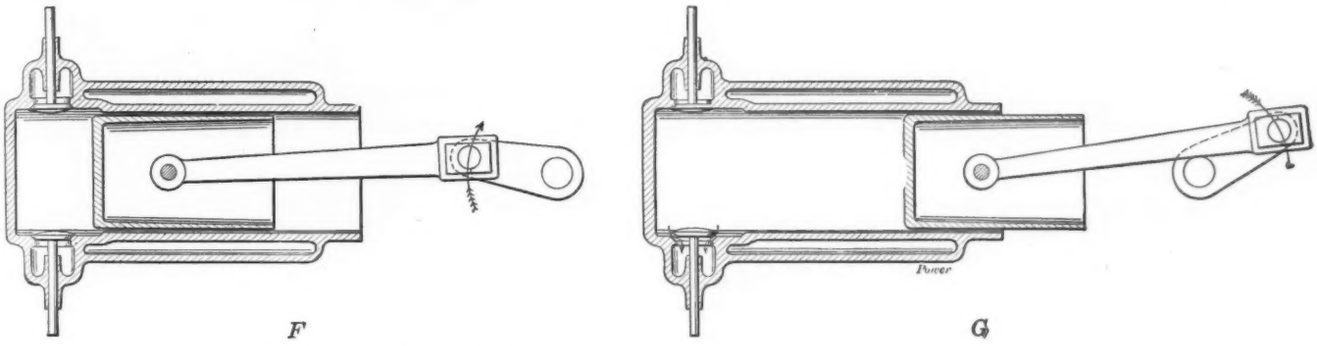


FIG. 4. THE THIRD STROKE; EXPANDING THE HOT GASES

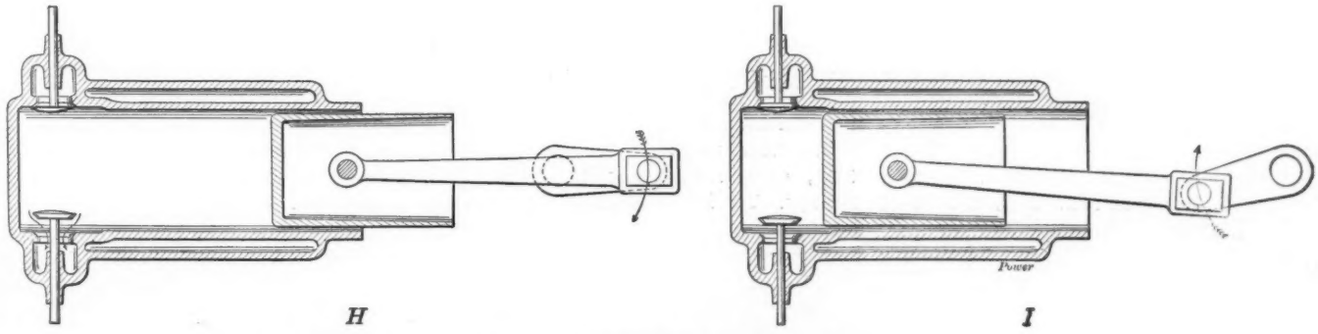


FIG. 5. THE FOURTH STROKE; EXPELLING THE DEAD GASES

Expansion, like all the other events except combustion, has practically a full stroke of its own. It begins as soon as the crank passes the inner dead center (*F*, Fig. 4), and continues during the outward stroke until the exhaust valve begins to open, just before the end of the stroke, as indicated at *G*, Fig. 4. While the crank is passing from this position to that of *H*, Fig. 5, the burned gases escape to the atmosphere under their own pressure, which is some 15 to 30 pounds above that of the atmosphere when the exhaust valve first cracks open. By the time the crank reaches the outer dead center (*H*, Fig. 5), the exhaust valve is wide open, and as the piston moves back on the instroke again, the burned gases are pushed out of the cylinder by the piston, which is, of course, being driven then by the flywheel if the engine has only one cylinder. The exhaust valve remains open, as indicated at *I*, Fig. 5, until the end of the expulsion stroke, which is the movement of the piston from the position *H* to that of *J*, Fig. 6, and then it closes and the inlet valve begins to open again, ready to take in the next fresh charge and begin a new cycle.

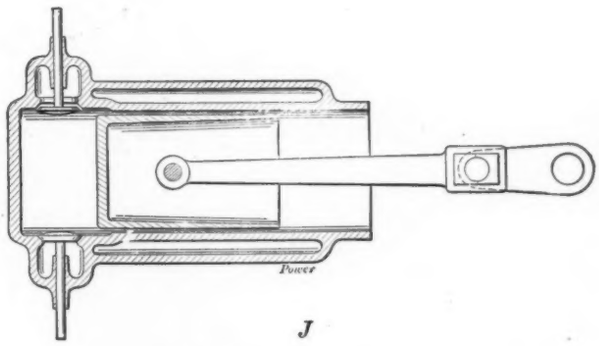


FIG. 6. END OF THE CYCLE

Summarizing the foregoing detailed explanation, the four-stroke cycle consists of taking in a charge during one outward stroke, *A*, *B*, *C*; compressing the charge during one return stroke, *C*, *D*, *E*; combustion while the crank passes the inner center, *E* to *F*; expanding the heated

gases to do work during a third stroke, *F, G, H,* and driving the burned gases out of the cylinder during a fourth stroke, *H, I, J.*

From this it should be clear that name four-stroke cycle (commonly miscalled four cycle) does not mean merely admission, compression, combustion, expansion and exhaust, but means that these five events are carried out in four strokes of the piston. The five events themselves constitute a gas-engine cycle; they can be carried out in two strokes, four strokes, six strokes or any other even number of strokes, and the number of strokes employed determines the type of the engine and, generally, the manner of performing the cycle. The statement that one sees sometimes in descriptions of new or proposed engines to the effect that the engine works on the four-stroke cycle, but completes the cycle in one revolution of the crank shaft, or some other period less than four piston strokes, is nonsensical because it contradicts itself.

The Bogart Single Acting Engine

A relatively recent addition to the list of single-acting horizontal engines is the Bogart machine, the single-cylinder form of which is illustrated herewith. The en-crank construction in sizes up to 100 horsepower and of side-crank construction when built with tandem cylinders; the latter form is employed in sizes ranging from 50 to 500 horsepower.

Figs. 1 and 2 show external and sectional elevations, from the same side of the engine. As Fig. 2 indicates, the main construction differs from the more usual arrangement in that the cylinder is supported near the rear end by a pedestal instead of being overhung, and is bolted to the frame at its extreme forward end. The rear end of the cylinder is also of unusual design. The combustion chamber is reduced symmetrically in diameter, beginning at the point where the piston travel stops, and the breech end is closed by a removable valve chamber carrying both the inlet and exhaust valves and the mixing valve. This obviates any packed joint common to both the cylinder bore and the water jacket, and therefore renders leakage between the two impossible. The valve chamber is water jacketed separately.

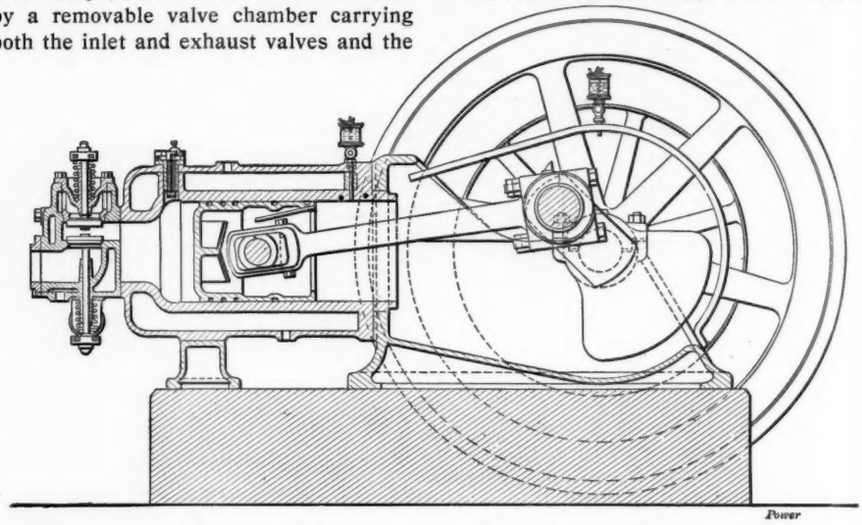


FIG. 2. LONGITUDINAL SECTION OF BOGART ENGINE

In small sizes all of the jacket water, and in larger sizes a part of it, is discharged into the exhaust pipe near the engine, and this water is taken out farther along by a separating muffler. The objects of this arrangement are to keep the exhaust piping cool near the engine and to quiet the exhaust.

The valves are of the usual poppet type, opened by cams and closed by springs. The inlet and exhaust valves are in line with each other vertically, as shown in Figs. 2 and 3, and a combined mixing and throttle valve is located in a cage on one side of the main valve chamber. Fig. 3 shows this construction and also shows the arrangement of levers, push rods and cams for operating all of the valves. The mixing valve is of the multiported cylindrical type and is moved by the governor to control the admission of both gas and air according to the load variations. Regulation, therefore, is effected by the constant-quality and variable-quantity method.

The ignition system is of the make-and-break class, with an igniter operated by an "iron-clad" electromagnet, and a separate inductance coil ("spark" coil) connected in either leg of the circuit. The igniter is located in the top of the combustion chamber near the end of the piston travel, as represented in Fig. 2. The timer is adjustable, of course, so that the igniter can be made to trip at any point in the crank travel within the practical range.

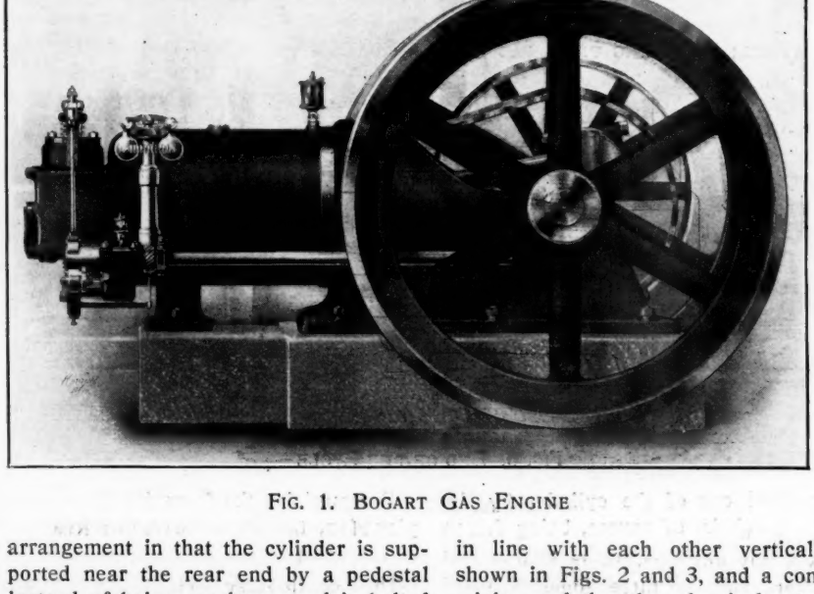


FIG. 1. BOGART GAS ENGINE

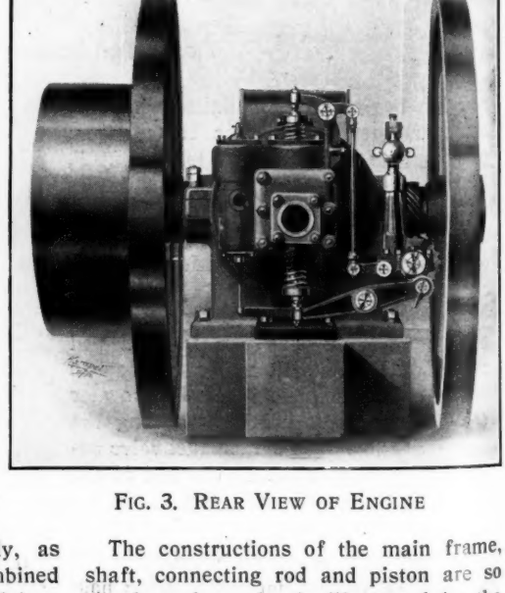


FIG. 3. REAR VIEW OF ENGINE

The constructions of the main frame, shaft, connecting rod and piston are so simple and so clearly illustrated by the engravings that a description of them is unnecessary.

Readers with Something to Say

Practical information from the man on the job. A letter good enough to print here will be paid for. Ideas, not mere words, wanted.

Long Runs of Power and Pumping Machinery

I am anxious to obtain information relating to long record runs of power and pumping machinery, either of the reciprocating or turbine type, especially the former. No doubt the readers of POWER are in possession of highly interesting facts in this connection and mention of them in the columns provided for that purpose would be appreciated by the engineering fraternity in general.

EDWIN D. DREYFUS.

East Pittsburg, Penn.

Boiler Inspections

So much has been said upon this subject that it would seem there was very little more to be said. There is, however, one point in connection with boiler inspection that is not given the attention that seems to be necessary from what is known to prevail generally throughout the country. This relates to the proper preparation of the boiler for the inspector.

If steam users and boiler owners would give more attention to such matters, they would save during the year, perhaps thousands of dollars. They insure their boilers, but they do not get, in many instances, the kind of inspection they should have, for the reason that the boilers are usually not properly prepared. Owners apparently think that they cannot afford the time to shut down for an internal inspection, and as a consequence, the inspector has to do the best he can under the conditions, fully realizing that his inspection is anything but satisfactory.

When a boiler has been shut down with the idea of making an inspection, it is often needed again within twelve or fourteen hours, and as a matter of course, it is impossible between the shutting down and starting up again to either clean or inspect the boiler thoroughly. There is not time, for the reason that the boiler is too hot, as no boiler set in brickwork can be cooled down properly under twenty-four, and sometimes thirty-six, hours. It is not of much use to the owner or to the insurance company to have an inspector go into a boiler that is so hot that he is obliged to come out for breath every few seconds; under such conditions he is unable to stay in the boiler long enough to give it the necessary inspection. Besides, the boiler should be thoroughly scaled and cleaned before the inspector goes in, to enable him to get at the sheets covered by scale, as many a dangerous crack has been hidden beneath a covering of scale.

Insurance inspections are made periodically, and the date at which the inspector is due, is easily remembered if any interest is shown. When the inspector arranges for the internal inspection, the boiler should be shut down, the plates taken off as soon as possible after steam is off and the boiler allowed to cool thoroughly, after which the process of cleaning, scalding and washing out should be started, the grate bars removed, the combustion chamber thoroughly cleaned and all soot brushed from the fire surfaces with a wire brush. Then, and only then, can the inspector do justice to the owner and to his own company.

Do not close your boiler if the inspector happens to be an hour late in arriving at your plant. He has other boilers to inspect, and perhaps the boiler that he inspected at the last place was so dirty that he had been obliged to secure extra clothing to enable him to keep his appointment with you, or he may have been delayed through other causes.

This is mentioned particularly because a very bad explosion might have been prevented on a certain occasion if the engineer had not been in such a hurry to close his boiler. This inspection was arranged for 11 a.m. on a Sunday. The inspector having been delayed at another plant arrived about noon and found the boiler closed. The engineer upon being asked why he did not wait a little longer, replied that he could not wait, as he wanted to go home. The inspector naturally felt annoyed, but the best he could do was to make an appointment to inspect the boiler on the following Tuesday—two days later. On the day intervening, Monday, the boiler blew up, fortunately killing no one, but entirely demolishing the plant, with a property loss of over $23,000. From the condition of the plates which were examined after the explosion, it is certain that had the inspector gotten into the boiler on Sunday he would have condemned it.

It will pay any concern to shut down its boilers two or three times a year in order to permit the inspector to make a thorough internal inspection, as the opportunity given to clean off the scale, and otherwise clean the boiler, will amply repay in fuel saved, for the time taken. The loss in heat transmission due to scale of the thickness of 1/16 of an inch will amount to as much as 10 or 12 per cent., and we have records of more than one case where, after the boilers were thoroughly scaled and cleaned and settings slightly altered, a saving in coal of over 60 per cent. was attained.

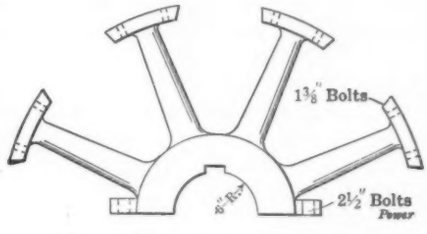
The insurance inspector visits scores of steam plants yearly, finds all kinds of apparatus and conditions, has new experiences, and is uptodate in matters pertaining to steam-plant equipment, and is in a position to advise sensibly. Inspection work is not ideal by any means; the work is hot, dirty and disagreeable. The inspectors strive to perform their duty in trying to detect weaknesses, defects and dangerous conditions if they are given the opportunity. Make an effort to have the boiler properly prepared for his inspection, and give him a reasonably cool and clean boiler to inspect. He will appreciate it and the owner will be getting not only his money's worth under the policy, but save hundreds of dollars annually besides. Boiler insurance without internal inspections properly made, we are sure is not what is wanted, but that is all that can be expected unless the inspector is given the opportunity to do his work.

G. M. DOUGLASS.

New York City.

Are the Rim Bolts in Tension or in Shear?

At a plant in this locality a new driving pulley is being installed and is causing much discussion. It is 13 feet in diameter with a 72-inch face and is built up in halves with arms as shown in the sketch. The wooden rim is to be placed after the wheel is in position and will be held to each of the arms by four 1½-inch bolts.



HALF OF PULLEY WITHOUT RIM

The controversy which has arisen among the engineers is in regard to the stress on these rim bolts. Some say that the bolts will be in shear while

others say that they will be in tension. Will some reader of POWER kindly settle the question?

PATRICK MULHAM.

Adams, Mass.

[This letter is reproduced from the July 5 issue. The sketch was accidentally omitted when the letter was first published.—EDITOR.]

Vibrations in Boiler Header

Last fall the writer had an experience in a lighting plant in Oklahoma which, although nothing serious resulted from it, he sincerely hopes he will never again be called upon to pass through.

It happened before the lighting load came on in the evening. The engineer had fired up one of the boilers and had cut it in but had not yet cut out the other one when the steam header began to vibrate lengthwise. The vibrations slowly but gradually increased until the engineer and the writer, who happened to be in the plant at the time, became alarmed and set about trying to find the cause of the trouble. As the vibrations appeared to be in step with the stroke of the engine, which was a Corliss, running at 100 revolutions per minute, we decided to start up another engine which ran at 325 revolutions per minute and then shut down the Corliss.

However, this change did no good, and the vibrations kept on getting stronger until the header appeared to move about an inch back and forth and the asbestos covering began to shake loose. We then decided to start up the Corliss again and to shut down the high-speed engine before the Corliss was up to full speed, hoping to thus set up vibrations out of step with the header. This ruse succeeded and the header began to quiet down so that by bracing it with planks we were able to bring it to a standstill without interrupting the service more than three minutes.

The question as to "what caused this trouble" naturally arose, but we were unable to account for it. Boiler No. 1 had been removed a short time before and a new one installed in the place of the old one at No. 2. The header had also been turned over so that No. 2 could be connected to it from above instead of from the side, as before. Aside from these changes the installation was as it had been for several years.

Another question arises: How far is it an engineer's duty and to what extent is he justified in risking the machinery and probably his life, in an attempt to maintain uninterrupted service? The public does not know and does not seem to care what risks an engineer takes, providing the service is not interrupted, but it is quick to complain if a shutdown occurs.

G. E. MILES.

Denver, Colo.

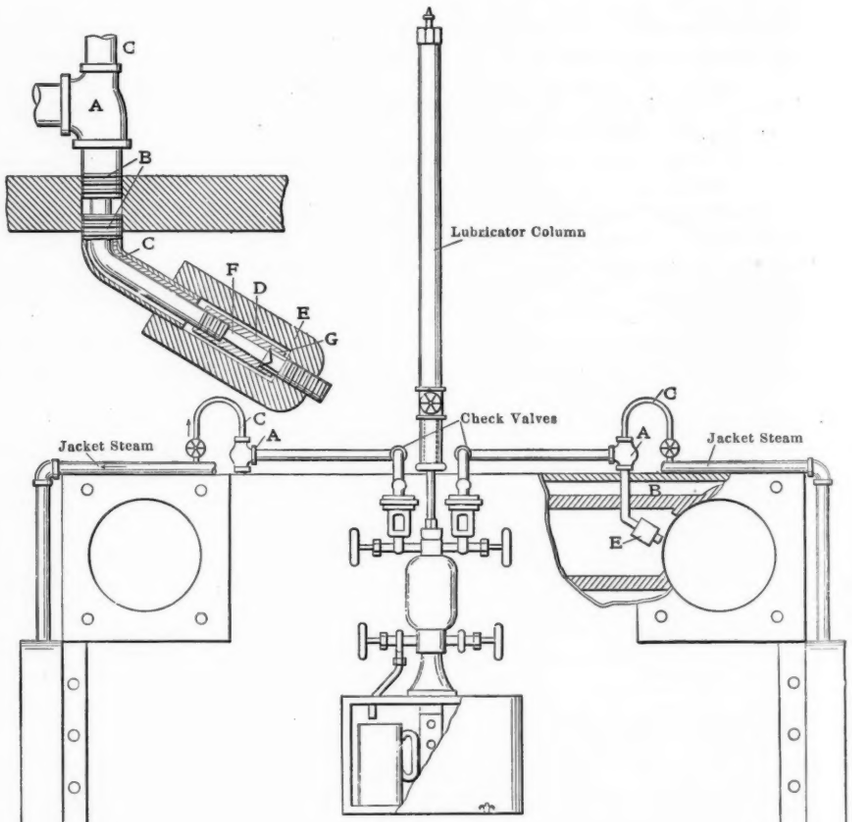
Lubricator Loop

There has recently been much discussion concerning the quantity of oil fed to steam-engine cylinders, but little has been said about the best ways of introducing it into those cylinders. The following method is a little out of the ordinary, but is taken from actual practice. The illustration shows in detail a method of atomizing the oil as it enters the low-pressure cylinder of a 20x40-inch cross-compound Corliss engine. The lubricator has a double feed, with a branch leading to a point a little to one side of the opening edge of each of the steam valves. Both feed branches, including nipple *B*, are of ⅜-inch pipe. Entering the reducing tee *A* is a ⅜-inch pipe *C*, which connects with the inflow pipe of the cylinder jackets, from which is taken the steam necessary to atomize the oil. It will be noticed by referring to the detail in the upper left-hand corner, that *C* is continued inside the nipple *B* and ends in the special expansion coupling *D*, which is inside the reducing coupling *E*, the latter capping the oil inlet inside the valve chest. The small hole *F* in coupling *D* is 1/32 inch in diameter at the upper end and increases to ⅛ inch at the lower end, its purpose being to expand the high-pressure steam, so as not to create any back pressure on the sight feeds through the small siphon holes *G*.

When the cylinder head was removed after this system had been in operation for a while, the usual unatomized oil at the bottom was lacking, and the cylinder began to rust inside of 24 hours, from which fact it was concluded that atomized oil has very little power to cling to the surfaces and penetrate the metal.

K. P. EVERETTE.

Boston, Mass.



DETAILS AND APPLICATION OF LUBRICATOR

Burning Oil Fuel

The purpose of this letter is to describe how a few changes in our oil-fuel installation cut down the oil consumption from 33 to 28 barrels a day; a saving of five barrels in 10 hours' run.

When I took charge, the steam connection to the burners was taken from a safety valve attached to a steam drum in the rear of the boilers about 14 feet from the front end. This pipe extended to the front of the boilers and down to the burners on one side, then across on the top to the other side and down again to the front burners. The plant was found to be burning too much fuel. An expert was sent for to investigate the cause but failed to improve matters. The flame frequently went out without any apparent cause, and this necessitated relighting the burners, on some occasions several times an hour. Having previously used this type of burner with satisfactory results, I

was convinced that the fault was not in the burner.

After due consideration, I decided that the chief cause of the trouble was due to accumulated moisture in the steam, caused by the unnecessarily long steam-pipe connection to the burners. I therefore removed all the piping from both sides, cut and threaded a hole in the top of the front steam drum just back of the breeching and carried the steam pipe through the breeching, making connections at the front in the old way. This change proved most beneficial; the trouble with the burners disappeared, and a big saving in fuel was at once noticeable. A significant fact is that the superheating is now done with waste gases.

We had a heater in connection with the oil pump but the oil, in my opinion, was not heated to the most satisfactory degree, so I also passed the oil pipe through the breeching and attained still better results.

I had noticed in the *Report of the Government Liquid Fuel Commission* that the heating of the air prior to combustion was recommended. Here again, I made an improvement in the furnace and closed up the air space immediately back of the "target." This space was supposed to allow just sufficient air to complete combustion, but this was not necessary; in fact, it was rather a detriment. I therefore increased the air space in front, which proved both economical and satisfactory.

Careful experiment, as well as extended experience, has shown conclusively that the more burners used under a battery, the greater will be the economy in fuel. However, it is best to use as little steam as possible, just enough to properly atomize or spray the oil.

The "target" is most beneficial as it maintains the heat, and if for any cause the burner should fluctuate, the heat from the bricks in the target will prevent the flame from going out.

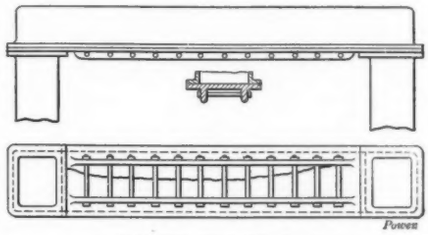
The draft has also considerable to do with the effective burning of liquid fuel; the bottom doors of furnace should be opened only just sufficient to admit the proper amount of air necessary for complete combustion. The tuyere holes and all other air holes in the boiler front should be entirely closed. The damper also should be regulated to get the best results; in ordinary cases the damper when one-third open will be found to be about right. A considerable saving is effected here, over the damper being wide open as is frequently the practice. But local conditions must determine how wide open both damper and bottom door ought to be. If a mud drum is used, be sure that it is properly covered and made air tight, as an increased fuel consumption is sure to result from air holes in the back or sides of the furnace.

T. K. McCARTER.

Temple, Texas.

Repair of a Casting

A leak developed in a casting forming part of the intercooler of our air compressor. As shown in the sketch it extended nearly the whole length of the casting, a distance of about six feet, and opened up about ⅛ inch.



CRACK IN CASTING

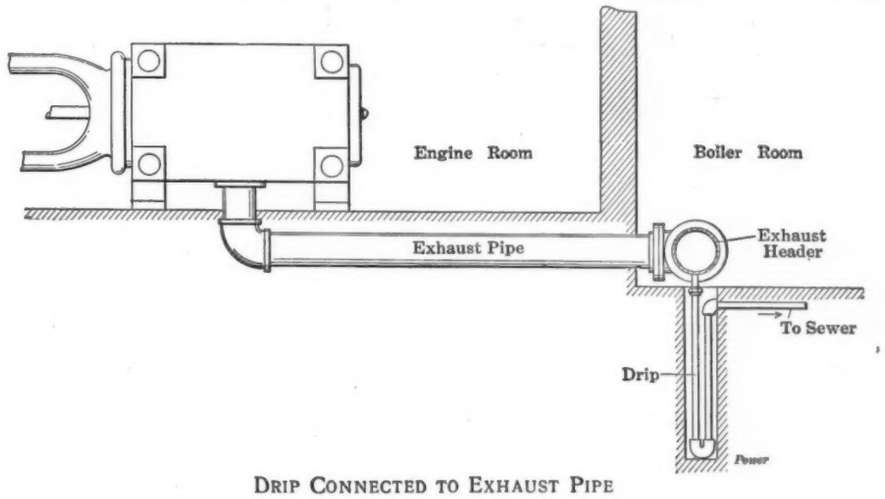
The conditions of service were such as to preclude shutting down the compressor for any length of time and as a result we were at a loss as to how the repair might be accomplished. It was finally decided to try "Smooth-on." The ribs were drilled for twelve ½-inch bolts, the "Smooth-on" applied to the crack, and the bolts inserted and tightened. This produced a solid joint and we have since been running, for some time, without any signs of a leak.

F. W. BELLINGER.

Harve, Mont.

Drip for Exhaust Pipe

The accompanying sketch shows a drip that I used successfully in cases where there was but little back pressure on the engine. It consists of a loop of 1- or 2-inch pipe, depending upon the size of the exhaust header, which is sunk into a hole in the floor as shown. The depth



DRIP CONNECTED TO EXHAUST PIPE

depends upon the pressure in the exhaust pipe, the column of water serving to balance the steam pressure and prevent the escape of any steam. The drip is open at all times and allows the excess water to overflow into the sewer.

Where the pressure in the exhaust line is not over one pound, a loop about 2½ feet deep has been found sufficient. It is an easy matter, however, to figure out the length of loop required for any given back pressure.

R. L. MOSSMAN.

Tampa, Fla.

Runaway Engines

I have noted many serious accidents occurring through the bursting of a flywheel, which has generally been caused by the engine running away.

It has occurred to me that all of these accidents could have been prevented if a stop valve had been placed in the main steam line leading to the engine. Of course, this valve must be placed inside the engine room, and within easy reach of the engineer. Then, if the throttle valve should stick or the governor break, causing the engine to travel at a dangerous speed, the engineer could always regain control of his engine by closing the stop valve.

To prove that a stop valve so placed has been the means of preventing an accident due to a runaway engine, I will relate the experience of a friend of mine who was in charge of a cross-compound Corliss engine. One day, on account of the steam pressure being low, he had occasion to open the throttle valve wide, to keep the engine running at normal speed. Shortly after this, the steam pressure began to rise rather rapidly and the speed of the engine increased. My friend ran to the throttle valve but to his dismay found that the wheel would not move. By this time the engine was traveling at a dangerous speed. Displaying presence of mind, he rushed up some steps leading to an elevated platform, from which he closed the stop valve. There is no doubt but that the accessibility of this valve, together with the engineer's efforts, were the means of saving a serious accident.

The engine had to be kept running day and night until the end of the week, so for the rest of the week the regulating had to be done by the stop valve. After the engine was shut down, the throttle

valve was opened for examination, and a large nut was found jammed in it, but where the nut came from has never been solved.

C. TRUBE.

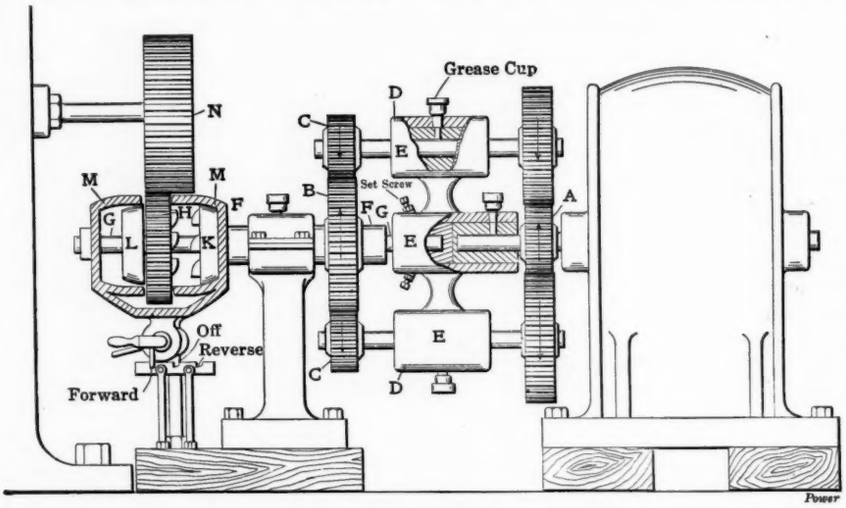
McKeesport, Penn.

A Complicated Drive

The illustration shows a rather curious form of drive between a motor and a large machine, and is an example of remarkable ingenuity for complicating a simple drive.

The problem was to reduce the speed of the motor to produce a forward and a reverse drive, and to stop the machine without stopping the motor.

If it be supposed that the motor gear *A* turns in the direction of the arrow, then gear *B* will turn as indicated; but if a brake be applied to gear *B* to stop it from revolving, then gears *C* will tend to run around it, and the two arms *D* will be revolved in the opposite direction to that of gears *B*. The bearing boxes are represented by *E*. The gear *B* is keyed to the quill shaft *F* and the two arms *D* are keyed to the solid shaft *G*. The direction of motion of these two shafts gives the forward and reverse drives to the machine. Gear *H*, on each side of which heavy lugs are cast, is free to move on the shaft. The castings *K* and *L*, the former keyed to shaft *F* and the latter to shaft *G*, have also heavy lugs cast on their inner faces to engage with those on the gear whenever it is pushed



ARRANGEMENT OF GEARS

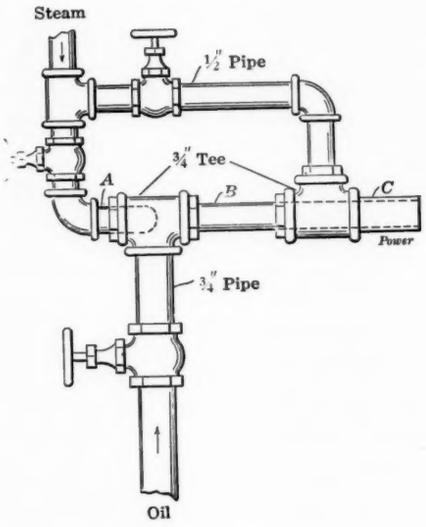
by the shifter *M* toward them. This causes the machine gear *N* to revolve in either direction desired. *K* and *L* are stopped revolving by friction between their beveled faces and those on the shifter *M*. This system of transmission has one good point about it, in that there is no shock to the driving lugs, for the machine will not reverse until the lugs are engaged and brake applied to the other drive.

S. TREMONT.

Cambridge, Mass.

Homemade Oil Burner

The accompanying illustration shows a homemade oil burner which the writer has employed successfully for some time.



HOMEMADE OIL BURNER

There are two of these in operation, one on a 75-horsepower boiler and the other on a 50-horsepower boiler, and they furnish all the steam that is required.

The burner is made entirely of pipe fittings. The ½-inch nipple *A* is simply forged down on the end to a 3/16-inch hole and a long thread is cut on it, in order to bring the end of the jet about ½ inch from the junction of the tee and thus form a siphon to draw the oil in. The nozzle *C* is a piece of ¾-inch pipe about 4 inches long, cut off straight at the end with all burs removed. The inner piece *B* is of ½-inch pipe cut with a long thread and ending flush with *C*, the threaded portion within *C* is filed or turned down, leaving a clearance of 1/32 inch all around through which the steam is sprayed.

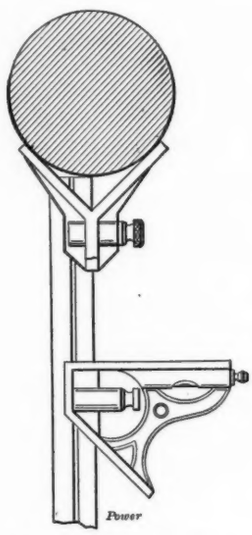
The burner is regulated by the valves in a manner similar to any other burner.

H. S. ARMSTRONG.

Jeanerette, La.

Laying Out a Key Seat

The accompanying sketch shows a convenient method of laying out the key seat on a shaft, by the use of a combination square. The illustration is self-explanatory and needs no further comment.



LAYING OUT A KEY SEAT

F. M. STERLING.

Middle Branch, O.

Proper Way to Drain a Boiler

I should like to hear from some of the readers of POWER as to the proper method of draining a header of a high-pressure boiler.

I have seen three different methods used. First, a 1½-inch pipe leading from the bottom of the header to a trap and discharging into the heater. Second, a 1½-inch pipe draining the bottom of the header, with a pitch of 6 inches in 10 feet, and additional drains in the back head of the boiler above the water line. Third, the pipe is located similar to that in the second case, except that instead of entering the header it drains through the blowoff pipe, being supplied by a swing-check valve and a stop valve.

Is the latter method practical? It is my opinion that it is not. I know of a case in which two boilers are run in the morning and at 10 o'clock one is banked until 3 in the afternoon. The header valve is left open all the time and while at times the boiler will fill up with water in two hours, yet at other times it will fill at the rate of only one inch in five hours. This is because the valve becomes obstructed with foreign matter.

H. M. WALKER.

Chicago, Ill.

Questions Before the House

Comment, criticism, suggestions and debate upon various articles, letters and editorials which have appeared in previous issues.

Trouble With Governor Bearings

An article by G. E. Mills in a recent issue brings to my memory an experience along the same lines with a high-speed engine and sticky governor. I was employed at the time as a fireman in a sawmill and as we were running overtime the engineer made it a practice to go home to supper at 5 o'clock and leave me in charge. There was a small engine belted to a direct-current dynamo to furnish lights to the mill and when light was wanted, the saw operator let it be known by sounding the whistle.

One night the engineer, as usual, had gone home to supper and the operator whistled for lights. I went into the engine room and started the dynamo engine, first getting it warmed up and running up to speed with no load. I then stepped over to the switchboard, raised the voltage to normal and started to throw in the switches. As soon as the load began to come on the voltage dropped, but by throwing the switches in and out a few times, I managed to get light.

I mentioned this to the engineer when he returned and he laughed at the idea, but nevertheless he took precautions and had the night watchman smear the governor bearings with coal oil. The next day he dismantled the engine and cleaned up the rollers in the governor bearings and no more trouble was experienced.

F. S. PUNCHES.

Williamsport, Penn.

Increasing the Capacity of Boilers

With reference to the article in POWER of May 24 in relation to increasing the capacity of steam boilers, I presume, after a careful reading of the article, that the data were taken from tests made, and call attention to the fact that one may secure under test conditions results which it would be imprudent if not impracticable to secure with stationary boilers operating under common conditions, for the following reasons: In 95 per cent. of such boilers we have scale to contend with and with an evaporation of, say, 4 pounds of water per square foot of heating surface the solids set free are to be considered. If the evaporation of a given boiler is doubled, the amount of solids is doubled also. Hence, the boiler must be cleaned twice as often one will say. But with double the evaporation per square foot of heating surface would not it be absolutely necessary to clean four times as often, having in view the increased danger from solids on the fire-swept surface on account of the greater amount of heat generated? Granted that solvents are used, would one care to operate a boiler under such forced conditions, knowing that the contained water was a solution and held matters in suspension, its capacity for absorbing heat diminished, and the danger of burning the sheets or tubes clearly increased? That we may do this in tests running a few hours is, of course, admitted, but the practicability of continuous operation with average feed water I seriously question.

That we should not have scale in steam boilers is quite true, but owners are seldom directly interested in ideal conditions and boilers must be run for power purposes, to produce results in the way of manufacturing. The owner is interested mainly in output and to a lesser degree in keeping down expenses in the power plant.

The problem of scale, therefore, does not warrant an increase in the present rate of evaporation per square foot of heating surface, which runs from 3 to 4 pounds. Indeed, even with this rate the owner has difficulty in keeping his boilers in constant operation and objects viciously enough when the repair bills due to scale are presented. True, we have certain localities, notably Massachusetts, where nature has granted water free from objectionable matter, but in the main the scale problem is a factor to be considered. Even where the solids are in small proportion the human equation enters and cleaning is neglected until overheated metal calls attention to the neglect. In my opinion, before increasing the rate of evaporation, the scale question must be disposed of.

In considering the evaporation per square foot of heating surface it might be said that the term is misleading. Consider a boiler with horizontal fire tubes. Assume a fire-tube boiler, 72 inches in diameter by 18 feet in length and having 70 tubes, 4 inches in diameter. We have apparently 1319 square feet of heating surface. Assume the rate of evaporation to be four pounds per square foot of this surface. Now it is conceded by all authorities that the actual heating surface, that is, the surface used, is one-half this amount for, beyond doubt, the lower half of a horizontal fire tube is of little value in absorbing heat. Hence, the real rate of evaporation is eight to one in a tube of this class and probably from five to six to one with a horizontal or semi-horizontal water-tube boiler. This should be borne in mind in calculating the evaporation with every type of boiler using tubes. Along this line and with a horizontal-tubular boiler it would be interesting to know the amount of evaporation per square foot of shell plate over the fire and then to remember that in doubling or tripling this rate we must increase proportionally the evaporation on the shell plates and that in these plates rests our security from explosions.

With regard to reducing the size of the tubes in order to absorb the heat generated by a doubling of the draft, it is evident that with boilers of the horizontal-tubular type we must at once look after the matter of soot regardless of the statement that soot will not occur due to the increased velocity of the gases. As the temperatures in the tubes drop notably farthest from the furnace, soot will accumulate. Western coals, commonly used, are notorious for soot and certainly when we arrange to double the amount of coal burned per square foot of grate then we have double the soot to contend with. Hence, with smaller tubes the result would be decreased evaporation or extra expense in removing soot. Possibly the experimenters will point out how to remove this evil with ordinary furnaces. Certainly we would appreciate their advices on both the soot and the scale ends of the subject.

In considering the doubling of the rate of evaporation in water-tube boilers, besides bearing in mind the foregoing, we must remember that the water and globules of steam are confined by the wall of the tube, the escape usually being at a given end. That part of the tube directly over the fire has the greatest work to do. Just how much water is evaporated in such a tube per foot under given conditions we would greatly like to know. If we assume a four-to-one ratio for the entire heating surface, what would be the actual rate at this point, say with a Babcock & Wilcox, a Stirling, or Heine type? Tests made of the Hohenstein boilers by the Navy Department showed an evaporation of 16 pounds of water per square foot of heating surface with oil fuel and with 275 pounds, gage, steam pressure. Such tests are, of course, valuable for naval purposes. A warship might

for a few hours in its life need such high evaporation with feed water free from scale due to surface condensers, but, even so, before stationary engineers consider the adoption of such high rates may we not await the naval engineers' solution of their troubles with tube failures in times of peace when boilers are run at perhaps ordinary rates of evaporation?

Granting the advisability of increasing the capacity of a boiler, doubling, tripling, or quadrupling the same as the gentlemen suggest, and assuming that they will look after the scale problem and the ash deposits, it would appear that the vertical fire-tube boiler would be the most promising one for results. All of the heating surface is available in this type. We could dispense with the water leg for stationary purposes, and with a reverberatory-brick furnace, fitted with grate surface to suit, we could use small tubes of any required length. It should be noted that in this type of boiler the globules of steam are not confined as in other types hence the safety under forced draft. We could even apply spiral baffles projecting part way down the tube for forcing the impingement of the gases against the sides of the tube. The heat absorbed by such metal baffles would be transmitted to the water. The shell, not exposed to the gases, would not be subjected to the severe expansion and contraction as in an externally fired boiler and our factor of safety would run up to 6 or better in the beginning, and remain there.

Further, in this type we have a superheater giving excellent results at minimum first cost, with practically no expense for upkeep. With a given fuel and a fixed draft, one could easily determine the proper length of a given size of tube to get a certain amount of superheat. With 200 pounds gage pressure, 387 degrees, one could get superheat within reasonable limits by raising or lowering the water level. With other types of boilers the superheater is a separate affair frequently located where it must be carefully looked after and where repairs are expensive. With the vertical, fire-tube boiler, we can get 50 to 90 degrees of superheat at little first cost and with waste heat.

Then again, with this type of boiler, the major troubles with brick settings are eliminated, for from a reverberatory furnace the products of combustion flow directly into the tubes similar to the delivery of gases into the chimney of a puddling furnace. With a short low-walled chamber surrounding only the furnace and the bottom of the boiler we would save in first cost of brickwork, in repairs to same and in avoiding heat losses due to the cracking of the walls which is common with boilers incased in long and high walls. The matter of insulating the shell to prevent heat losses is a simple one, comparing its temperature, 387 degrees, against even the lowest temperatures in the furnace.

Again, with this type, floor space is saved as against the horizontal boiler. That head room is needed is true, but in most instances this is not an objectionable feature. In the above I have pointed out what seems to be valid objections to increasing the capacity of steam boilers of the stationary type under existing conditions. Under tests we may get certain results and these tests are certainly of value in blazing the trail for designers. On the other hand, if the gentlemen engaged in the fascinating occupation of solving boiler troubles, at the expense of our genial relative Uncle Sam, will kindly devote their attention to the scale problem and solve this satisfactorily, we, as engineers, boilermakers and inspectors, will more readily listen to the argument in favor of increasing the boiler capacity by means of forced draft.

T. T. PARKER.

New York City.

Vacuum Trouble

I read with interest Mr. Reynolds' account of his "Vacuum Trouble" in the May 31 issue. I have recently had trouble in this line myself.

The pumping equipment in a certain plant consisted of a horizontal duplex triple-expansion condensing pumping engine having a surface condenser and an independent air pump. This pumping engine was working against a head of 60 pounds and a suction lift of 15 feet. The machinery was new, the plant having been running only about two months. At the time in question, the air pump was carrying a vacuum of 27 to 27½ inches. Suddenly I noticed that the vacuum started to drop and a peculiar knocking began in the pump. I was unable to locate the sound and thought at first that it was in one of the steam ends and that one of the piston heads had come loose, but upon investigating I found that the three heads on both sides were firmly in place. I started the pump again but the knocking still continued although the vacuum held up. I thought then that something might be under the water valves but upon stopping the pump and opening the water ends, I found all of the valves in good shape and seating nicely. Upon starting up again, the vacuum went up to 27 inches; suddenly, the knocking started and the vacuum began to drop, going back to 15 inches. Thinking possibly that a tube was loose in the condenser, I took the head off the condenser and after cleaning the tubes, tested it thoroughly by placing a blind gasket on the intake end (the suction line had no foot valve) and bypassing the water from the discharge line into the condenser. Everything was snug. Then I tried the bypasses from the discharge decks of the water cylinders to the suction decks, but found everything tight and the valves holding in good shape.

As a last resort, I went over the suction line and found a number of minute holes in the two cast elbows in the line. I painted these with a light preparation of metal cement and found when I started up that the knocking was gone and that the pump held the vacuum nicely.

I do not know why this trouble did not show when the pump was first started unless it was because these many small holes were filled with a fine powdered dust or sand from the casting and this had not had the time to work out.

M. BAILIERE.

Norwalk, O.

Fake Diagrams

Mr. Westerfield's letter in the issue of May 10, in reply to my questions in the issue of March 15, is a very poor, slip-shod explanation of the defects shown by his Fig. 1 in the issue of January 18.

The shortness of the diagrams at the point of release he calculates to have explained, but neglected to blame the engraver for the very sharp point of cutoff.

Mr. Westerfield states that I should be able to see that the back-pressure line has been omitted. Just what connection the back-pressure line would have had with the point of release, or the length of the diagram, requires explanation. My eyesight is good enough for me to see that the back-pressure line is very clearly shown, instead of being omitted; and that the atmospheric line is omitted.

On the same page, in the issue of January 18, Mr. Westerfield gives us another account of his experience.

His statements in this letter do not hold water, and the letter was answered by readers, pointing out the variations in the statements, but no explanation in reply was made by Mr. Westerfield.

In the December 21, 1909, number, he also gave us some of his experience as a "Trouble Man." The diagrams which he showed with this letter were very strange; in fact, I believe such a condition as he described did not exist, and I said so in my letter, replying to his article.

Mr. Hughes also disputed the correctness of Mr. Westerfield's statements. These diagrams in Fig 1 show a very good steam line and an excellent point of cutoff. Anyone who has had much experience with indicators and valve-gear adjusting knows that it is almost an impossibility to get so sharp a point of cutoff.

The diagrams in Fig. 2 are good average diagrams; notice the difference in the point of cutoff shown in Fig. 2 compared with that in Fig. 1.

Perhaps Mr. Westerfield *has* had a very extensive indicator experience, but I know and so should he that such a sharp point of cutoff is an impossibility from the same engine as that from which the diagrams in Fig. 2 were taken. I am not

satisfied with his explanation and still say that the diagrams do not look genuine.

Mr. Kirlin also disputed these diagrams, but Mr. Westerfield failed to defend himself in that case.

Here are three letters from Mr. Westerfield, and all of them have been disputed by different readers.

The only defense Mr. Westerfield makes is that in reply to my letter on page 496 in the issue of March 15, and in this he only explains half of what I disputed; the half which he does explain he does so by blaming the engraver.

A poor excuse is worse than none.

HARRY W. BENTON.

Cleveland, O.

Central Station vs. Isolated Plant

I read with much interest Mr. Naylor's letter on the above subject in the May 3 issue. To a man in Mr. Naylor's position, familiar with the situation in all its details and thus able to judge and weigh everything for or against the central-station service, the proposition no doubt looks quite different than it does to many readers of POWER. We know what would be the probable cost of a kilowatt delivered to the busbars in a well managed noncondensing plant of the size required to supply the service as stated, but with no details in regard to the heating and ventilating requirements in this particular case, it is merely guesswork for an outsider to try to size up the situation. Where, say, 2000 boiler horsepower is necessary seven months in the year for heating purposes alone, it would seem that the coal- and ash-handling proposition would not be much different whether the boilers were operated at high pressure or not; and as 2000 boiler horsepower would go a long way toward supplying power for light, it would be interesting if Mr. Naylor would give us an idea of what it means to supply heat and ventilation for a mammoth establishment such as he has in charge.

As to the question, "will the isolated plant be able to withstand the onslaught of the central station?" it is the writer's opinion that most any properly laid out and well managed plant will for several reasons. It is true, of course, that the central station has rapidly reduced the cost of producing current through favorable location, ability to run condensing, low cost of handling coal and ashes and minimum of attendance per unit of output. But at the same time, the central station has now reached a point where further reductions in cost of producing current mean such small fractions of a cent that the isolated plant in charge of the National Association of Stationary Engineers man is producing a reduction in cost which is rapidly catching up with the figures established by the central station. In addition, in the isolated plant, good use can be made of the exhaust steam where condensing facilities are lacking. Besides this, the isolated plant does not have to contend with the expense of transmitting current to long distances, which must be quite an item with the central station in a large city like Chicago.

The central station in Chicago has increased its output at a tremendous rate, in fact, judging from contemplated extensions, it seems that the demand is steadily in excess of its capacity. But it is equally true that most of the modern office buildings, hotels and factories erected in the last year or two in Chicago and those now under construction have their own private power plants.

Whether this is because the building owners find it more economical or because the central station is not equipped to handle the additional load would be interesting to know and I trust we will hear more from readers of POWER who are in position to give reliable figures in regard to this question.

R. CEDERBLOM.

Chicago, Ill.

Oil as Fuel

I read with much interest the letter in the May 24 issue under the title "Oil as a Cause of Boiler Failure," and would like to make a few remarks concerning the subject. While not wishing to say that the failure of the flue in the Lancashire boiler in question was not caused by the presence of grease or oil, I do say that my experience with the use of oil in boilers, extending over a period of 12 years in the oilfields, has been that oil in boilers is *not* usually fatal.

The boilers used in the oilfields are of the portable locomotive type, and in the past 20 years thousands of these have been in use in northwestern Ohio and Indiana. Four-fifths of these boilers have had from one to two pails of crude oil (petroleum) pumped into them every 24 hours and in not one instance, to my knowledge, has the oil been the cause of any bad results; in fact, it is well known that the use of crude oil in the boilers effects a saving in fuel, and this is the main reason for its use.

During my entire experience I have known of only one boiler explosion in the oilfields, and in this the crown sheet gave in, killing one man and throwing the boiler some 50 or 60 feet. I am unable to say whether oil was used in this boiler or not, but have reason to believe that it was.

If any engineer knows, for a certainty, of any boiler failure caused *directly* by the presence of oil in the boiler, I would be pleased to hear of his experience.

D. A. DICKINSON.

Lima, O.

Perpetual Motion

In the May 3 issue, Mr. Kirlin describes a so called perpetual-motion device. In subsequent issues several writers tried to prove that it will not work. Nearly all of them assume that it is in motion and then hunt around for "moments" and such truck to counteract an assumed force acting upward, losing sight of the fact that with the construction shown there can be no unbalanced upward force to begin with. An upward force acting on the exposed plungers does not act to turn the machine, but acts on the air within, and since air pressure acts equally in all directions it would force out all plungers alike, hence, the forces on all of the plungers are equal. So why look for a force to balance a force that does not exist? Again, the plunger falling into its cylinder on one side instead of not doing any available work, as one writer says, would on the contrary force out a plunger on the opposite side, and give as available work the buoyancy due to the transferred displacement. But the force acting on the second plunger would react on the first and force it back to its initial position. And there we are, where we started from, hence the falling plunger, so called, does not fall. The problem with perpetual-motion machines is not how to keep 'em going, but how in the world to stop 'em. Since, if they ever got started, the uniform force acting would increase the speed to such an extent that there would be no machine left.

Recognizing this, I have made what I term an accelerating motor. This device depends for its operation upon accelerated motion.

I am a first-class inventor but a poor draftsman, so will refer to Mr. Perras' sketch (June 14, page 1086) to illustrate my machine. He says that the weight of the floats descending on one side is helped by their buoyancy on the other side, or *vice versa*. If that is so, why not increase the weight to the maximum; that is, to the point where their weight is equal to their buoyancy? See the fallacy? That is the trouble with all perpetual-motion cranks, they want heavier weights, longer levers, bigger things and less friction, whereas, I use as little weight as possible and utilize the friction to hold the speed constant, as will be seen when we come to that part of it. In my machine, I use two tanks, the one in which the floats (Mr. Perras' sketch) ascend is filled with mercury, and in the other, the one in which they descend, is a variable air or gas pressure, occasionally equaling or exceeding the pressure caused by the mercury.

The floats are rubber spheres, hollow and filled with a light gas. Hydrogen or nitrous oxide is preferable. If we submerge in water a toy rubber balloon such

as the children play with and let go of it, the balloon will rise to the top with an increasing velocity and will jump out of the water so that it will rise higher than the point from which it started, if we consider that it was first at rest on the surface.

When I brought my experimental machine to the attention of the boys at the lodge, all that I could hear for a while was, "It is against all principles; conservated energy; a pendulum will rise no higher than the point from which it fell;" and much more "dope" of the same order. When I showed them that the rubber ball would rise higher than the point from which it fell, and explained the philosopy of the thing, they did not have so much to say. You see it works like this:

The uniform force acting on the ball accelerates its motion; the accelerated motion raises the ball higher than the surface of the water, and this distance multiplied by the time and by the weight of the ball equals the surplus energy, which is plain enough if you can see it, although one of the boys said that the friction of the balloon going through the water heated the air in the balloon, hence expanded it and gave an increased displacement, which goes to show that he does not understand the subject. By mechanics, the kinetic energy of a moving body is proportional to the weight times the square of the velocity. So it will be seen that weight does not have as much influence as velocity.

Again, "I proved by mathematics" that the final speed of the descending ball or balloon and the distance it rose above the surface was proportional to the square of the hight of the column of water or other liquid, but as the process is somewhat "complex" and hard for those not versed in higher mathematics to understand. "I will omit the proof." It can be seen that the acceleration can be made any amount desired by varying the hight of the column of fluid, and this together with the vacuum tank gives a means of regulating the speed to a hair.

If we concede the fact that the rubber floats can enter and leave a vacuum without gain or loss of work, it is true that, depending upon the degree of vacuum or the density of the medium within the tank, the direction in which the floats rotate will depend on whether the medium is lighter or heavier than the floats. Now, the mercury accelerates the floats upward and the vacuum adds to its effect to produce rotation. Then, acceleration gets in its fine work, and when the speed is brought up to the normal point, we can utilize the friction to expand the gas in the tank. This will create more pressure to retard the velocity of the floats and offset the acceleration under constant load. If the load changes, the regulator on the liquid tank will vary the hight of the liquid according to the requirements. In order to stop the motor we pump up the air pressure in the tank to equal the mercury pressure and there you are. With a little more pressure in the tank, the motor reverses. I believe that this is the first time that anyone has ever heard of one of these "something-for-nothing" machines reversing.

All that you have to do to start this motor is to let out gas from the tank until the required speed has been reached, when natural forces come into play and do the rest.

On account of the high price of rubber, although gas is cheap enough, I have not built a working model yet, but expect to do so when I can sell enough stock. You see, my experimental machine is so small that the friction interferes with its continuous operation, but I expect to overcome this in a large machine, because with more and bigger balloons there will be more gas, hence less weight and less friction.

ALBERT IHLENFIELD.

Cleveland, O.

In the June 14 issue of POWDR there is a description of a perpetual-motion machine by F. M. Perras. He states that the machine will not work because of friction between the floats and the walls of the opening in the bottom of the vessel. The fact is that if the friction were not too great the machine would revolve in the opposite direction and the floats would be expelled at the bottom as long as the head of water was maintained in the vessel. The reason for this is that the force tending to expel the floats at the bottom is equal to a column of water having a diameter equal to the diameter of a float and a hight equal to the head of water in the vessel, plus the weight of the floats, etc., on that side.

The force tending to raise the floats in the water is only equal to the amount of water which they displace plus the weight of the floats, etc., on the opposite side. The machine is, therefore, a water-wheel of very poor design.

THOMAS HENRY.

West Toronto, Canada.

[A similar discussion was received from H. F. Liedtke, Philadelphia, Penn.]

It is said that William Crookes was very much surprised when he constructed his famous radiometer to find that the vanes rotated in a direction contrary to that in which he had expected them to rotate.

If F. M. Perras will construct his machine, illustrated in the June 14 number of POWER, I venture to predict that if not too tightly fitted, it will run in spite of friction, but in the other direction. The buoyant effect of the water will not equal the downward pressure on the bottom ball, because the buoyant effect is equal to the weight of the water displaced by the balls. The downward pressure is equal to the weight of a column of water in cross-section equal to the cross-section of the balls at their center and in hight equal to the distance of the bottom ball below the surface of the water.

In other words, the downward pressure is the pressure on a round plug at the bottom of the tank, with diameter equal to the diameter of the balls, less the weight of the water displaced by the balls.

So the balls on the tank side would descend instead of rise and as they descended they would allow the tank to empty itself. Hence, power would be required to run the machine which is a kind of water motor instead of a perpetual-motion machine.

JOHN A. COOK.

Bham, Ala.

Novel Feed Water Heater

In the June 7 issue, Mr. Schreiber criticizes my description of a feed-water heater, which was published in the issue of April 19. He has evidently forgotten that I have described an apparatus which has been in successful operation for a number of years, and that I have not merely made a suggestion for a new type.

I should like Mr. Schreiber to give one reason why a duplex pump would not work under the given conditions.

In regard to the oil in the exhaust, it is readily seen that only a small part of the exhaust steam is condensed and returned to the tank. Moreover, the feed water is taken from the lower part of the tank, which is always more than half full, and as oil floats on water but little oil finds its way to the boilers.

R. S. SEESE.

Urbana, Ill.

Boiler Explosions

Peter Van Brock, I believe, is mistaken when he states that the chief cause of boiler explosion is low water.

I think that the great majority of boiler explosions are caused by other conditions than low water, such as scale and mud, bad management and, in particular, overpressure.

I was in one boiler explosion once. This one was caused by scale. I do not care to be in any more explosions. It is four years since the accident and I have been working around boilers every day since.

In the plant where the explosion occurred I had nothing to say about the cleaning or management of the boilers; but where I am now employed I have entire charge of the boiler management and certainly am careful that the boilers are kept clean and in good operating order.

JOHN BERKLEY.

Homer, Ill.

Boiler Explosion in Kentucky

By O. Monnett

A decrepit boiler, an over-weighted safety valve and an ignorant fireman form the combination which was responsible for the recent explosion at Bowling Green, Kentucky. The circumstances surrounding this disaster point to the urgent need of proper laws for supervision and inspection.

If anything can be added to the literature of boiler explosions which will aid in showing just what operating conditions are in this country, and point a moral which, if observed, will result in benefit not only to the owners and operators themselves but also to the public in general, it is the duty of the investigator along this line to make the facts known.

Although in the technical magazine is the place where naturally such reports will be looked for, still if the inside facts could be laid before the public in general through the medium of the daily press, it would sooner arouse public interest and a general realization of the extreme carelessness with which steam boilers are operated in all parts of the country.

There is no doubt but what we are generations behind European practice in this regard. As a matter of fact we are the laughing stock of the world, were it a laughing matter, when it comes to the supervision of steam boilers. Last winter some of our greatest savants got together and seriously discussed the question whether cast iron was suitable for superheated steam. It was definitely settled in England thirty years ago that cast iron was absolutely unsuitable for this service. Yet the question is just beginning to be serious in this country. This shows how we are lagging behind in some regards, and in the matter of boiler inspection and supervision our methods are probably in worse shape than in any other branch of engineering.

Knowing that there had been a boiler explosion some time previous in a sawmill at Bowling Green, Ky., and happening to be in the neighborhood, it was decided to sojourn in that city over Sunday and make an effort to pick up something that would add to the store of knowledge of this subject and perhaps lend its influence toward the ultimate correction of some of the operating abuses practised in the rural boiler plant.

It was found that the boiler was an ancient one, containing forty-six 3-inch tubes and constructed of innumerable small sheets. The longitudinal seams were all double riveted, but the ruptures occurred seemingly without much regard for the seams, tearing through the middle of the sheets in all directions. The boiler had been in charge of a young inexperienced fireman, and it is asserted that the lever-and-weight safety valve was tied down or heavily overweighted. The story goes that a visitor to the plant came up to the boiler and noticed that the gage indicated 165 pounds pressure. Upon remonstrating with the young fireman, and calling his attention to the danger of blowing up the mill, he replied, "I don't care. Let her go." Upon hearing this the visitor rushed to the owner, who was working nearby, telling him of the danger. He had hardly delivered his message when the explosion occurred, killing one workman and injuring another so seriously that he died later. Whether or not the safety valve was really tied down, or whether an overpressure was on the boiler at the time it is impossible to vouch for. In view of the absolutely disreputable condition of the metal as found it would hardly seem necessary to assume much overpressure in order to account for the explosion. Moreover, if the steam gage was of the same vintage as the boiler, no reliance could be placed upon it as a pressure recorder, and it seems impossible to believe that the boiler could have stood the above mentioned pressure long enough to register on the gage.

What Was Left After the Explosion

Be that as it may, the boiler was blown completely to pieces, the failures as above pointed out being principally in the sheets. When a boiler is built of good material the seams are always the weakest points, there being no such thing as a 100 per cent. joint in boiler work at present. But as time goes on the plates are subjected to external and internal corrosion, pitting, grooving, breathing due to varying steam pressure, and other actions which tend to deteriorate the metal, so it frequently occurs that the joints become the strongest part of the boiler. Whenever the failure occurs in the plates, leaving the majority of the seams intact, it indicates that enormous deterioration has taken place, and is always seen where very old boilers explode. The front head was blown away from the rest of the boiler, the plates tearing off half way between the end of the sheet and the first curvilinear seam, indicating that this seam, although single riveted and originally of only 56 per cent. efficiency, was much stronger than the sheet itself. The boiler was liberally patched on the bottom but in no case, as far as could be observed, had the patches let go. A patch on any boiler most certainly weakens the structure, and when in a boiler explosion it is found that the patches are intact, it further indicates the bad condition of the original metal of the boiler. It was practically impossible to find a spot on the sheets where the approximate thickness of the original metal could be determined. On the smoke-box extension the metal had wasted away to about ⅛ inch in thickness. Laminations were apparent in the fractures at nearly all points.

It is understood that several suits have grown out of the accident for the recovery of damages from the company, but the latter holds that the accident was entirely the fault of the inexperienced fireman.

Whose fault it really was that such conditions should be allowed to exist is not so difficult to determine. A combination of decrepit boiler, unskilled fireman and an overweighted safety valve is certainly one that is hard to beat, and is something that can be laid directly at the door of the public itself. The inevitable result of such a combination is seen in the accompanying illustration.

There is no law in Kentucky requiring an owner to have his boiler inspected. There is no law requiring an owner to hire a competent man to operate his boiler. There is nothing to prevent a man who is totally ignorant of boiler operation from accepting a job as fireman in a boiler plant; in fact, he is the man who will most likely get the job, as he will work cheaper than anybody else. Until laws covering these subjects are passed, not only in Kentucky but elsewhere, we will have repetitions of these criminal conditions and it will be nobody's but the public's fault.

Accounts of boiler explosions have appeared and will continue to appear in the technical press for a long time to come and will be read by a class of men the great majority of whom appreciate the importance of the question, but until the public mind is aroused to the deadly possibilities of the old boiler and the careless operator, nothing much will be accomplished. If it could become a matter of common knowledge that steam boilers, stuck away in obscure places, are as dangerous as a dynamite factory, then some politician who might know no more about a steam boiler than about a soup kettle would be glad to take up the question as a political issue and we would get something done. Politicians will not take up this question until the public is educated to the importance of voting for it, however, and thus it will, no doubt, be many years before we see satisfactory legislation along the lines so much to be desired.

In investigating boiler explosions, particularly in the rural districts, one is impressed with the firm hold which the low-water theory has upon steam users. Low water is the cause invariably assigned for a boiler explosion by this class of users. There is an impression that a boiler will be perfectly safe forever if there is plenty of water kept in it when steaming. Second-hand boilers are in great demand among such people. The probable age of a boiler as effecting its safety does not seem to enter into their calculations.

Before the wreck of the Chewtown (Penn.) boiler explosion had been cleared away the management was busy planning where it could get some more "good" second-hand boilers to replace those damaged in the explosion. Similarly at Bowling Green another "good" second-hand boiler was scraped up from some place and the work of the mill went merrily on. It is needless to say that the firemen who attend these "new" second-hand boilers will have special instructions about keeping the water level correct at all costs, with the result that if they let go they will at least release enough energy to mar seriously the surrounding landscape.

As a matter of fact, a boiler begins to deteriorate from the time it is built. The forces of oxidation attack the metal unceasingly. Any boiler, however perfectly built or managed, will explode *if kept in service long enough,* merely from the deterioration of the plates. It remains for expert inspection and supervision to determine how far this deterioration has gone and be governed accordingly, before the boiler has an opportunity to demonstrate what an enormous amount of energy is stored within it.

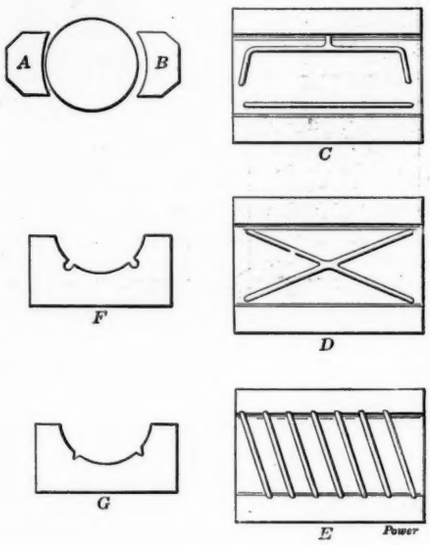
Oil Grooves in Bearings

By C. R. McGahey

The failure of main bearings to run properly after having been newly babbitted is invariably due to improper workmanship. Simply lining up and pouring the bearing does not mean that it will be a finished piece of work, nor can we depend upon the bearing to run cool; but we can save ourselves a great deal of work in the way of hand scraping by properly arranging the journal for the reception of the babbitt. Many bearings made of babbitt will give much better service from the start without the aid of hand scrapers, especially when the scraping is done with no object in view other than simply going over the surface, as we see it done.

The fact that the journal will dissipate heat in proportion to the amount of surface in direct contact, would point to the desirability of a perfect contact, yet this contact must have a certain relief so as to allow the journal to run cool. For instance, the box *A* would tend to run cool while *B* would run hot. All bearings expand when running and if we make no provision for this, we will have trouble. The form shown at *A* could expand and still have ample clearance as the babbitted portion has a slightly larger curvature than that of the shaft. It is the oil entering between the two surfaces that reduces the friction, therefore a bearing that is made to allow a free entrance of oil will run cooler than one not so made.

The next important point is the oil grooves. I have noted with interest the remarks of some about the uselessness of oil grooves, but will say from practical experience that I have taken bearings with no oil grooves which were giving some trouble and by simply putting some good grooves in the surface, no further trouble was experienced. I am a strong advocate of good, clean, deep oil grooves. Sketches *C*, *D* and *E* illustrate three types of oil grooves but the style of groove will depend upon the bearing to be lubricated. The one shown at *C* is a good form for large bearings while that shown at *D* is a common type. Either will work well, if large enough and having the proper depth, so that it will hold a sufficient amount of oil. The cutting of the groove is shown at *F* and *G*. That shown at *F* is a common form which is cut with a small chisel; it is seldom cut deep, but will hold the lubricant. That shown at *G* makes a groove which is easily cleaned, but the grooves should be deep enough to carry plenty of oil.



TYPES OF OIL GROOVES AND PROPER RADIUS FOR BEARINGS

One of the better forms of oil grooves is the spiral groove. This is shown at *E* and can be formed by simply wrapping a coil around the bearing to be poured. Place a good piece of manila paper around the journal and wrap a piece of cord around it. This will take up the space closed in by contraction and the cord will form the oil groove. This is especially good on small bearings and saves time and scraping. The original surface of the metal without being scraped is much better as a bearing surface than the one presented after scraping; however, on large bearings it is hard to get a surface that will not need scraping and fitting after being poured.

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Power and The Engineer

Editorial

The Education of the Operative Engineer

Power-plant engineering now offers opportunities for the application of learning of a high and specialized sort. Men with this sort of learning acquired at technical schools are taking executive and supervisory positions and making mere mechanicians and underlings out of the men with less educational attainments. The technical man frequently makes mistakes for lack of the practical man's training; the practical man is often not broad enough and big enough and well educated enough to be the responsible head of the department. If these two men could be rolled into one he would be an ideal man for the job.

In the contest for supremacy the technically-educated man has all the advantage in position, in connections, in prestige and usually in presentability, ability to make a favorable impression and to present his case; and it is incomparably easier for him with his knowledge of principles to acquire what the ideal man needs of practical skill than it is for the practical man to acquire what the ideal man needs of education.

If the big positions are to be filled by those who have come up from the ranks these must be given the means for acquiring the education which will round them out to the requirements of the situation.

Many a man has done this on his own hook. If he had not, many a big job would be looking for a man today. He could have done it easier and more effectively if there had been a course laid out for him to follow, regular terms and grades as in an established school, recognition when one grade had been completed and he passed into another, and the incentive ahead of him all the time of ultimate recognition as a master in his art, such as the technical student has in his diploma.

The difficulty which the National Association of Stationary Engineers has encountered in its educational work is the diversified condition of its membership. You cannot teach algebra to a man who does not know his arithmetic, and while all of them can enjoy and get something out of lectures, etc., it is impracticable through delicacy about admitting elementary deficiencies, difficulty and expense of procuring instructors in various grades, to make the association into a systematic organized school with a regular course of study and promotions.

Suppose a young man who is about to start as an engineer could enter such an institute or guild as is contemplated in the Institute of Operating Engineers, as a junior apprentice, could be told what it was necessary for him to study and what experience it was necessary for him to have to pass to the grade of senior apprentice, could be advised what books to study if he must study alone, what courses to select if he wishes to study by correspondence, or told what classes had been organized or arranged for either among Institute members of his own grade or in public or endowed institutions of learning in his neighborhood. This course would be within the reach of his present attainments, would be such that a man of ordinary ability and a limited education could pick it up and follow it. One part of it would lead naturally into another, and all of it be applicable to the practical work which he was following or of that general educational character necessary to make a man as well as an engineer of him. He would naturally settle down to getting through that line of work in the two years allotted to it. He would have a definite program to follow and a definite end in view, and if at the end of the two years he had qualified himself as far as both practical experience and study were concerned he could pass to the grade of senior apprentice and would have won his first success in his progress toward his object of being a master operating engineer.

If he does not stick to his job and make the most of its advantages in learning the practical end of the business, i.e., if he is unsatisfactory as an apprentice workman, if he does not follow the line of study laid out, he will remain a junior apprentice. His status in the Institute and in the vocation will depend upon his success in following the prescribed course and there would be every incentive for him to do so. It would be like a school or college, and a man would naturally go on or get out, not remain perpetually in one class.

With the growth of the Institute he would be likely to be apprenticed to one of its master members who would give to him the interested attention which he in turn would give to his apprentices when he became a master himself.

The Use of Superheated Steam

The use of superheated steam in engines and turbines has been such that its behavior can now be predicted with more or less certainty. At the present writing, no engineer can successfully plead ignorance as an argument for or against its use. It is now pretty clearly understood that the economy resulting from the use of superheat is due to the prevention of condensation both in steam pipe and cylinder, rather than to any great increase of efficiency in the steam itself. Nothing succeeds like success—that is, nothing is so good a preventive of cylinder condensation as steam which is initially dry or slightly superheated. The exact amount of superheat necessary to prevent condensation varies with circumstances but it is probably from 5 to 10 degrees of superheat for each one per cent. of moisture present at cutoff.

Current practice favors the use of an inclosed superheater connected to the boiler, rather than the independent type. Where a superheater is placed in the passageway of hot gases without interfering with the natural heating surface of the boiler, there will be no loss of efficiency in the latter; in fact, there will be sometimes a slight gain.

Experiments both on stationary and locomotive engines show a possible economy in steam consumption of from 15 to 20 per cent. and a net heat saving of from 10 to 15 per cent. with a comparatively low superheat of from 100 to 150 degrees.

The engine economy is most favorably affected in those engines which are particularly subject to initial condensation and wet steam on account of low speed, poor proportions, etc. Locomotive engines are particulalry susceptible to improvement in this respect because of the large amount of condensation which is ordinarily present when saturated steam is used.

Experiments made thus far show a continual improvement in the economy of locomotives as the amount of superheat is increased up to 180 degrees. The maximum would probably be higher for locomotives than for stationary engines, due to the causes mentioned. With a superheat of from 50 to 150 degrees at the throttle, little trouble will be experienced from the increase in temperature. Additional care must be used in lubricating the valves and pistons of the engine and a high grade of cylinder oil must be used.

Troubles will be experienced with the pumps attached to the steam line unless special attention is paid to the packing and the lubrication.

When superheat of a greater degree is used, there will be trouble, and plenty of it, both in the boiler and engine room, unless the piping and machines have been especially designed for high temperatures. Cast-iron fittings become more or less unreliable at temperatures of over 500 degrees Fahrenheit and some grades of iron are brittle and dangerous at these high temperatures. Ordinary gaskets leak and blow out. The packings of the pumps rapidly deterioriate and there is trouble with the lubrication on both engine and auxiliaries; serious cutting of slide valves frequently results, and metallic packings become necessary on the piston rod. If there is much fluctuation of temperature, great trouble is experienced with the piping on account of uneven expansion and fittings are sprung and sometimes broken.

Our advice to anyone who contemplates using high degrees of superheat in an old plant is most emphatically "Don't," because the disadvantages will more than offset the gain in economy. Like most panaceas, superheat must be used with discretion and is not a cure for all the evils in the calendar. It is doubtful if temperatures of over 600 degrees are advisable in any plant but when a new installation is made with piping, fittings and gaskets designed for high pressures and temperatures, the result is much more satisfactory than when an attempt is made to graft new ideas onto old equipment. Remember that a moderate superheat, 50 to 100 degrees, can be employed without serious difficulty and will pay a better return in proportion to the trouble than higher degrees, and that the high temperatures are only desirable when the whole equipment is designed especially for their use.

The Conservation of Water Powers

The people have awakened to the fact that this is an age of power, that electrical distribution and the multiplying uses of electricity have increased the value of every water power many fold, and that if they sit quietly by and see them appropriated as the coal and oil have been appropriated they will pay in perpetuity a baron's toll for any of that power which they, however indirectly, consume. They have therefore demanded that the unrestrained relinquishment of the rights of the people in their inheritance be stopped, and that power sites be developed by the people for the benefit of the people, or by groups of the people incorporated for the purpose under such restrictions that the corporate group may impose upon the rest of the people such a charge as will render a fair profit upon the money which they have actually invested, and no more. It makes no difference whether the sites are developed by the Federal Government, the State government or by private capital so long as the charge put upon their use is sufficient only to pay the interest and sinking-fund charges and actual cost of maintenance and operation, plus the fair profit to private capital if private rather than Governmental enterprise and means are invoked. Neither government would any more than get its money back, but the State where the water powers are located would profit in cheap power for their inhabitants and by the influx of industries to take advantage of that cheap power.

In view of this simple and self-evident condition one wonders through whose spectacles the Honorable William E. Borah, United States senator from Idaho, was looking when he conceived the following utterance, delivered when the subject was under debate in the senate:

"These power sites are our wealth. We have the means to control them and to dedicate them to the use of the people. They are a part of the State's heritage. It is a violation of every principle of the Constitution to withhold them from our use. If you tax them for the Federal Treasury will not our people have to pay the tax? Do the people of the older States pay any such tax? If Illinois or Massachusetts receives thousands or even millions of dollars as a revenue for their water power and Idaho receives nothing, but, on the other hand, pays thousands or millions into the Federal Treasury, is there equality among the States? The old States make these power sites a source of incalculable revenue out of which to pay the expenses of the State and lessen the general taxes. But we must not only pay our taxes, but, in addition, pay this revenue to the general Government."

The water powers of Massachusetts are owned by private interests. If the State gets "millions of dollars" from them in revenue, the millions of dollars come out of the ultimate consumers of the products of the water powers and not out of the corporations which own them. If the unappropriated and undeveloped water powers of Idaho and the rest of the country are developed by the interests unrestrained by their retention in them of their rights and the power to fix rates by the people, the people will pay the cost of their surrender, as they pay now in every coal bill and in the price of every article into the cost of which coal-made power enters the surrender of their inherent rights in the country's mines.

The comet is a "has been" just now, and won't be heard of again for 75 years; so is the slovenly, lazy man of the engine room, but he will never be heard of.

It has been estimated that the strength of the average horse is that of five men. Few engineers can back up the assertion that they feel as strong as a horse.

Don't block the lever of a safety valve against the roof to prevent the escape of steam. It isn't worth it.

Inquiries of General Interest

Steam-engine Efficiency

A steam plant shows a boiler efficiency of 62 per cent. using 1100 pounds of coal of 10,000 B.t.u. value per hour. If the engine indicates 250 horsepower, what is the efficiency of the engine?

F. A. H.

The heat contained in the coal is 10,000 times 1100 or 11,000,000 B.t.u. At 62 per cent. efficiency of the boiler plant, this is 6,820,000 B.t.u. delivered by the engine. A horsepower is equivalent to 33,000 foot-pounds of work every minute or 1,980,000 per hour.

A heat unit is equivalent to 778 foot-pounds. Dividing 1,980,000 by 778, gives 2545 heat units per hour as the equivalent of one horsepower. Multiplying this by 250, the horsepower of the engine, gives 636,500 thermal units as the equivalent of the energy furnished each hour by the engine. Dividing by 6,820,000, the heat furnished to the engine, gives 0.0933 or 9.33 per cent. as the efficiency of the engine.

Piston Speed of Single-acting Engine

What is meant by single-acting engine, and how is the piston speed found?

J. H. R.

In a single-acting engine the steam acts on one side of the piston only as in the Brotherhood and Westinghouse types. The piston speed in feet per minute is found by multiplying the stroke in feet by the number of revolutions per minute, or by multiplying the stroke in inches by the number of revolutions per minute and dividing the product by 12.

Valve Setting

How will I set the valves on a Greene, a Corliss and a Brown engine?

J. C. D.

In a general way the valves of all engines are set by the same method, and general knowledge of the fundamental principles will enable you to set the valves of any engine. Adjust or make the eccentric rods and valve stems the right length. Then with the engine on the center turn the eccentric in the direction that the engine is to run until you have the proper lead at the right end of the cylinder.

Direct Side of Pump

Which is the direct side of a duplex pump?

F. E. D.

It is that side on which the rocker moves the valve in the same direction that tne piston travels.

Questions are not answered unless accompanied by the name and address of the inquirer. This page is for you when stuck—use it.

Wavy Lines in Diagram

What makes the wavy lines in a high-speed indicator diagram?

J. D. D.

A variety of causes contribute, among which are too little tension in the drum spring, too light a spring on the indicator piston, too much travel for the drum, too heavy take up and hook on the drum cord making it "whip." If smooth lines with curves which are even and probably truthful are wanted in high-speed engine diagrams, they should be short, and stiff springs should be used. For 300 revolutions per minute the diagram should not be over 2½ inches long nor more than 1¼ inches high.

Horsepower of Belting

I am taking power from a shaft driven by a six-inch belt running over a 30-inch pulley, making 165 revolutions a minute, and am paying for 15 horsepower. This seems to be too much and I would like to know if it is possible for a six-inch belt to transmit so much power?

J. F. L.

At the speed the belt is running, nine horsepower is a fair load and 15 horsepower is an overload of about 80 per cent. It is possible to transmit a much greater horsepower than the accepted rules allow, because they are not calculated for the ultimate strength of the belt but for what it will carry with safety for a number of years.

Frequency of Lighting Current

At how low a frequency can incandescent lamps be supplied with alternating current without causing inconvenience to the users?

L. J. G.

Investigations made several years ago with carbon-filament lamps indicated that 30 cycles was the lowest frequency possible without discomfort to the lamp user. With tungsten lamps it is probable that a considerably higher frequency would be required to avoid discomfort.

National Association of Stationary Engineers

How old is the National Association of Stationary Engineers, and what are its aims?

E. F. W.

It was organized in 1882. Its aims are:

The education of its members in the art and science of steam engineering.

To protect the interests of competent engineers in their vocation.

To enroll all competent engineers.

To impart information beneficial to the calling.

To assist members to obtain employment and to procure by law greater safety in the operation of steam plants.

Long Suction Pipe

What precautions should be taken in laying out a long suction pipe for a pump?

V. H. N.

All joints should be air tight and the pipe should have a gradual rise without depression at any part as any unevenness in the grade will be liable to form air pockets which will prevent the satisfactory working of the pump.

The Heat Unit

What is a B.t.u.?

R. B.

"B.t.u." are the initials of the words British thermal unit. One British thermal unit is the quantity of heat necessary to raise the temperature of water one degree Fahrenheit, from the temperature of maximum density—about 39 degrees Fahrenheit.

Terminal Pressure

How is the terminal pressure found in an indicator diagram?

A. C. W.

If the expansion line is prolonged, guided by the eye, to the end of the diagram as though the exhaust valve had not opened, its distance from the atmospheric line measured in the scale of the indicator spring will be the terminal pressure.

Position of Knife-blade Switches

How should a knife-blade switch be set on a wall or panel with regard to the opening and closing of the blades?

R. B.

The switch must be mounted so that the blades cannot close by their own weight. The best position is with the handle pointing straight upward when the switch is closed.

New Power House Equipment

The Ajax Four Valve Engine

What the inventor and the manufacturer are doing to save time and money in the engine room and power house. Engine room news.

This engine is built by the Hewes & Phillips Iron Works, Newark, N. J., which firm has entered the field as builders of Corliss, four-valve, automatic, high-speed engines, fitted with inertia shaft governors. The "Ajax" engine is made in simple, tandem-compound, cross-compound, condensing and noncondensing types, in sizes ranging from 100 to 600 horsepower. In Figs. 1 and 2 are shown a front and a back view of the engine.

The builders have recently purchased the shop rights to manufacture and use the Robb-Armstrong-Sweet inertia shaft governor, and all of their engines of the automatic, high-speed, four-valve type are equipped with this device.

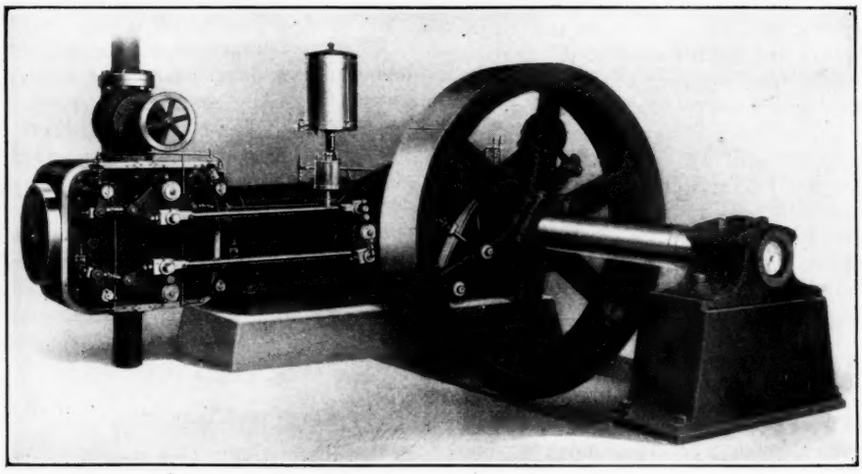


FIG. 1. VALVE GEAR OF AJAX FOUR-VALVE ENGINE

Designed for 125 pounds working pressure, the cylinder is made with the exhaust chamber separated by an air space from the cylinder barrel. The two steam and two exhaust valves have straight passages through them, as shown in the cross-sectional view, Fig. 3. The valves have an equal disposition of metal on each side of the vertical center line and the outer members of the valve are tied at the center with a sufficient number of bridges to meet the requirements of the work. The valves rest on their natural seats, steam pressure, gravity and vacuum acting along the same vertical lines. Attached to one side of the cylinder are two steam- and two exhaust-valve brackets operated from independent swing plates attached to separate eccentrics. The exhaust eccentric is fixed in its throw, but can be varied as to the angular position with reference to the crank. The steam eccentric is of variable throw and comprises a part of the governor.

The arms attached to the valve stems are connected to two swing plates which produce a long dwell when the valves are open and a corresponding condition when they are shut, but at the moment of opening and the moment of closing, the speeds of the valves are most rapid. Neither the steam nor the exhaust valves are ever entirely at rest except at their moment of reversal. This condition prevents any tendency for the surfaces to seize. Fig. 4 shows diagrams of the valve movement. The steam valves are practically balanced when they are moving toward the admission or closing points, producing a minimum of strain on the governor and valve connections.

The frame and guides are of a new pattern of the heavy-duty tangye type in which ample provision is made against the discharge of oil either by splashing or creeping down the surfaces of the casting. A glance at the illustrations shows the general arrangement of the parts and the particular disposition of the material. In general the bed is of rectangular box form, having flowing base lines which have a grooved form extending entirely around the lower edge of the casting, giving complete security against oil reaching the foundation.

The main pillow block is made in four pieces, the top, bottom and quarter boxes being lined with babbitt metal hammered into place and fitted to the shaft by boring and scraping. The quarter boxes are backed by heavy steel plates planed true. These plates are adjusted by set screws. The lower section of the bearing is made hollow and provision is made for water circulation through it, permitting control of bearing temperatures under unusual circumstances.

Gun-metal cast iron is used in the crosshead, which has two adjustable shoes fitted to the guide. When adjustment is required the hexagon nut at the side of the crosshead is loosened, then the nut at the rear of the shoe is unlocked and a slight turn of the steel spool adjacent to it, moves the shoe forward or backward, tightening or slacking the running fit of the crosshead.

The steel crank shaft is made with a

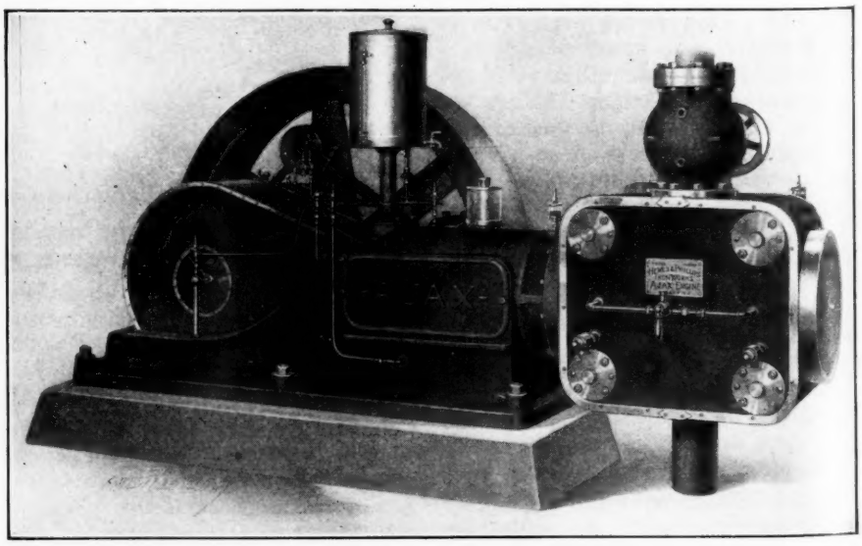


FIG. 2. CRANK SIDE OF AJAX FOUR-VALVE ENGINE

swell in the center where the flywheel and generator are located. Long tapers or fillets are used wherever the shaft changes its diameter.

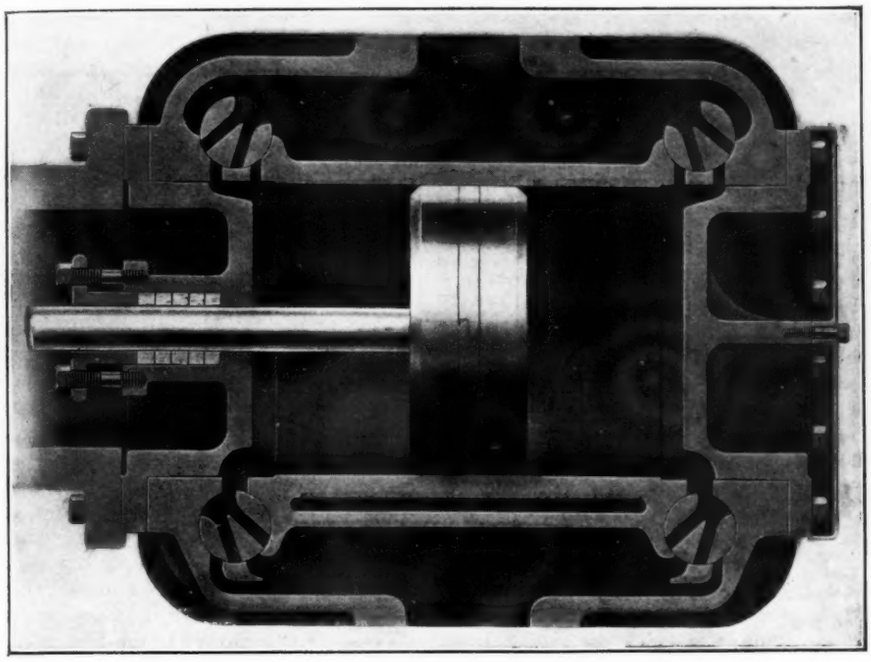


FIG. 3. SECTIONAL VIEW OF CYLINDER

A crank of the counterbalanced type, heavily proportioned is pressed onto the shaft and keyed in place. The crank pin is forced into the crank and the end riveted over.

The flywheel is heavily proportioned and where furnished for alternating-current generators, it is made of sufficient weight to secure proper regulation when generators are run in parallel. The wheel is designed with one set of oval arms and is so proportioned that the strains arising from centrifugal force will be far below the elastic limit of the material employed.

A steel connecting rod, made with solid ends, is provided with wedge adjustment for taking up wear. The wedges are so disposed as to keep the length of the rod constant. The ends of the rod are fitted with bronze boxes bored and scraped to fit the pin. Straight and curved arrows indicate the direction for adjustment.

A bull-ring type of piston is used and is so arranged that it can be adjusted with set screws. One center packing ring in sections is provided and it is cut in four or more parts, having lap joints provided at the under side of the joints with brass clips set out by spiral springs. The follower is scraped to the spider and the rings are accurately fitted into the bull ring. The bull ring has a bearing the entire width of the piston.

All of the important bearings of the engine are oiled by a system of piping. The bearings are provided with sight-feed adjustment. The oiling system consists of a tank superimposed on the engine bed and supplied by a mechanically operated oil pump, attached to a filter tank suitably located in the subbase under the tangye frame. Means for separating sediment from the oil are provided in the tank. The pump has a capacity far in excess of the engine requirements. The overflow from the tank on the engine bed discharges automatically into the filter tank.

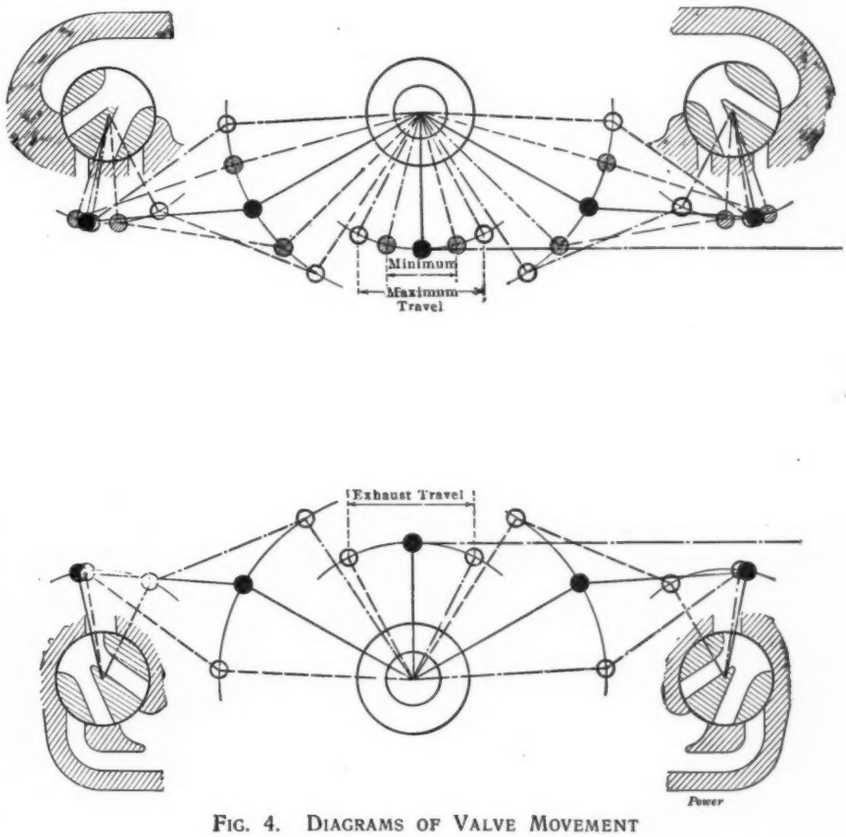
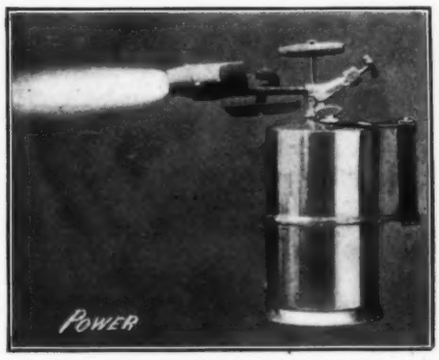


FIG. 4. DIAGRAMS OF VALVE MOVEMENT

Hauck Kerosene Torch

The accompanying illustration shows the general appearance of this torch. It is simple in design, and strongly built. It is adaptable for various heating operations, light brazing and tinning. It produces an intense clear flame.



HAUCK KEROSENE TORCH

The burner is designed to use kerosene oil, and the torch is so constructed that the tank will remain cool, while the burner is being operated. Only one pound pressure is required on the torch.

This torch is made by the Hauck Manufacturing Company, 140 Cedar street, New York City.

Anti-Smoke Convention, Minneapolis

The International Association for the Prevention of Smoke convened at Minneapolis, June 29 and 30 and July 1, for the consideration of matters of interest to those responsible for the supression of the smoke nuisance in our cities. Papers on the program for this, the fifth annual session, included "The Harrington Automatic Stoker," by Joseph Harrington, chief engineer of the Green Engineering Company, of Chicago. Mr. Harrington's paper took up the subject of the installation of stokers of less than 200 horsepower, in which the disproportionate cost of the stoker as compared to the rest of the plant ordinarily offers a serious objection. Attention was called to the fact that the average small boiler is set too low for regular stoker installation and generally there is not available the room for ashpits and satisfactory combustion chambers. In view of the large field for a stoker which could be easily applied to small boilers already installed the question had been taken up with the idea of producing a stoker with low grate surface, small grate area, simple and cheap, which could be used under the above conditions. The paper described the design of stoker which had been brought out to meet these conditions. The stoker consists essentially of a self-contained structural steel frame, practically independent of the brickwork, and provided with movable grate bars inclined at an angle, upon which the coal is pushed from a dial plate, by means of the driving mechanism. The stoker also has an arrangement whereby the ash is continually removed to the front of the boiler as fast as formed. A complete description of the device will be given later.

C. F. Hodges, of the B. F. Sturtevant Company, Hyde Park, Mass., presented an illustrated paper on "Forced and Induced Draft and its Relation to Combustion." Typical installations were shown and the peculiarities of the two types were brought out in the lantern slides.

"Taylor Stokers and Steam Boiler Efficiency," was the subject of a paper by R. S. Riley, of the American Ship Windlass Company, Providence, R. I. Mr. Riley explained that smokelessness and efficiency did not always go together, and on the other hand, it is quite possible to make considerable smoke and yet realize satisfactory efficiency. From the point of view of the operatives, he said that efficiency was the main object, although if smokelessness could also be obtained it was very desirable. Excess air, it was pointed out, was the great enemy of efficiency and care in keeping this item down to the necessary requirements was given as one of the principal considerations when both efficiency and smokelessness were to be realized. Mr. Riley's paper contained considerable data on boiler and furnace efficiency as obtained with Taylor stokers in practice and contained a detailed description of the stoker itself, which has been fully treated in POWER AND THE ENGINEER.

S. S. Howell, of the Under-Feed Stoker Company of America, Chicago, read a paper on "Furnace Draft and its Relation to Smoke Prevention." The paper emphasized the fact that a strong draft is necessary in getting the air through the fuel, overcoming the resistance of the boiler and breeching, and getting the gases up the stack. With bituminous coal distilling and breaking up into its constituents it is essential that the air permeate the finely divided particles, for the purpose of perfect combustion. The evolution of gas, it was shown, was very rapid, and therefore the air should be supplied with considerable velocity; the resulting forcible impingement of the air and fuel being depended on to accomplish the necessary mixing, this being the critical point in the process. Proceeding with the paper, Mr. Howell took up in detail the calculations for stack, breeching, combustion areas, grate surface and all other items entering into this phase of steam-plant design. The result of the analysis showed that, using the ordinary formula, stacks are frequently built too small in diameter, are lacking in hight, and that sufficient attention is not always given to details of the design of the gas passages to get the best results from the standpoint of economy and smoke.

One of the most interesting papers was that by Prof. R. H. Fernald, engineer-in-charge United States Geological Survey, Case School of Applied Science, Cleveland, O. The paper was entitled "Gas Producers as Related to the Smoke Problem." It pointed out that with the present rate of using coal the visible supply would be exhausted by the middle of the next century, and that therefore it was necessary to begin to use the lower grades of coal, lignites, etc., wherever possible. Experiments at St. Louis and Norfolk were cited to show that 2½ times more power could be developed with producers than with steam plants of ordinary design, using the same amount of coal, and that frequently the low-grade varieties gave as good results in gas engines as the more expensive coals.

It was shown that the use of producers meant the elimination of the smoke nuisance and that central plants for the distribution of gas for power purposes were perfectly feasible as one solution of this problem. The different types of producers on the market were illustrated and a large amount of data on the coal supply of different states and their characteristics when used in producers was given, together with records of test runs by the Government, which have been issued from time to time in bulletin form.

Health Commissioner Hall, of Minneapolis, in speaking of the administration problems in regard to smoke suppression, gave his views as to the detriment to health and property from this source, and hoped for the time when electrification or centralization of power plants outside of the city limits, would solve this difficulty.

One of the sessions of the convention was devoted to railroad smoke, representatives of the Illinois Central, the Chicago Northwestern and the Chicago, Milwaukee & St. Paul railroads being present. It developed that the Illinois Central might be characterized as a "Steam Jet" road, especial attention being paid to this method of smoke suppression. The steam jets are introduced in the firebox about twenty inches above the grates and work in conjunction with a blower in the stack which is automatically turned on when the throttle is closed.

On the other hand, the Milwaukee relies mostly on the brick-arch system of reducing the smoke, every engine being equipped with this device. The Northwestern, it was brought out, relies on a a combination of the brick arch and steam jet, inclining to the latter method. It developed that according to the opinion of the smoke inspectors present, from 30 to 50 per cent. of the total smoke in cities was caused by the railroads, the percentage varying from the lower figure in the winter, to the larger one in the summer time. It was unanimously decided that electrification was the ultimate solution to this problem.

The next convention will be held at Newark, N. J., the time being the last week in June, 1911. Officers for the ensuing year were elected as follows: Paul P. Bird, of Chicago, president; Daniel Maloney, of Newark, vice-president, and R. C. Harris, City Hall, Toronto, Can., secretary-treasurer, the latter being re-elected.

The hospitality of the city was extended to the visitors at all times and special arrangements were made for entertaining the ladies. Of the social features, an informal dinner at the Commercial Club, and an excursion to Lake Minnetonka, were the leaders, both being most enjoyable occasions.

There should be a society for the prevention of cruelty to machines as well as to animals. Did you ever see a brutal operator pound a nice bright finished part of his machine?

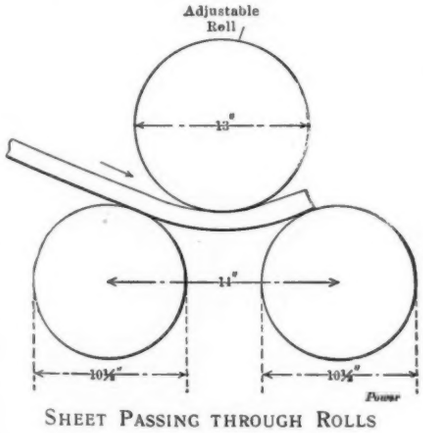
Probable Cause of Recent Explosions

By T. T. Parker

A significant fact connected with a number of recent boiler explosions is that in each case the boiler was constructed with one sheet on the bottom, extending from head to head. The defects of this type of construction are pointed out and its discontinuance recommended.

Reviewing the Canton boiler explosion as described in the May 31 issue of POWER, we may accept as conclusive that the boiler failed by the shearing of the rivets at both longitudinal seams, which were of lap-joint and double-riveted construction. The shell was built in two sheets each extending from head to head, the joints or seams being on each side below the lugs and, of course, below the upper row of tubes so that each longitudinal seam was inaccessible for inspection either externally or internally.

The feature of special note is that this is the third explosion within a few months of boilers built with one sheet on the bottom extending from head to head. The boiler that exploded at the Robinson clay-product plant, Midvale, O., in December, was built in the same manner and the boiler that exploded about the same time at Shelton, Conn., was built with one sheet on the bottom. In 1902 a boiler built in this manner exploded at the Swift plant in Chicago, killing 13 men and injuring several others. Also in 1898 or 1899, another similar boiler exploded at Willy's mill, Appleton, and resulted in heavy property damage and the killing of one man. The initial fracture of the latter took place at the long seam, while the Swift boiler failed on top in the solid plate from head to



SHEET PASSING THROUGH ROLLS

head. Probably other explosions of boilers built in this manner have occurred that the writer has no knowledge of. It is the purpose of this discussion to point out the defects in this type of construction and the bearing such matter would have upon boilers of similar construction now in operation, with the hope of pointing out reasons that may explain such explosions with a view of possibly preventing future explosions. The publicity given to boiler explosions, together with the vast number of intelligent engineers and superintendents who read and assimilate the articles in POWER, prompt me to place my views before them, knowing that if I am in error as respects the conclusions, the mistakes will be pointed out. If, otherwise, perhaps, an explosion will be averted.

In the construction of a cylinder the plates composing the shell must be cold rolled into circular shape. Consider the ordinary boiler-shop rolls used for this purpose. The roll shown in the sketch is a common type; the upper roll being the adjustable one. The flat boiler plate enters at one side and is passed along under the upper roll until it strikes the second lower roll. It is evident that the plate is not curved from a point perpendicularly below the center of the upper roll to where the plate touches the second lower roll. It is also evident that the edge of the plate directly opposite to that first entering the rolls will have a flat uncurved section and the width of each section will vary with the diameters of the rolls. Large-diameter rolls are needed for heavy plates, and for long plates. With plates rolled to form one-half the circumference and 16 or 18 feet long, the diameters of the rolls must be increased to prevent springing in the middle; the rolls being supported at the ends only. Even then, with sheets of this length, we find considerable springing, as may be expected with cold rolling. With hot rolling difficulty is also experienced, the plates increasing in width as is evidenced by the mills requiring larger percentage as regards thickness.

To curve the flat section at each end of the plate where the horizontal seams are located is a most important object. In many instances the sledge is used for this purpose and the metal mauled into a rough irregular shape. S. F. Jeter described in POWER, December 21, 1909, the results of this found on the seams of a boiler wherein one plate formed the full circle, and showed with illustrations the actual deformation along the line of the horizontal seam. But with a sheet forming half the circumference and allowing for the spring of the rolls, it would appear reasonable to expect the plate to be more out of a true circle than would a full-course sheet. Consider then the effect of one sheet on the bottom as compared with a plate forming a full circle but only 6 or 8 feet long. True, some shops use special tools to force the plate evenly into a circular shape. Also, other shops use a section of very heavy plate as a liner over the lower rolls, placing the sheet on this liner to finish the operation. But this is impracticable with sheets 16 feet long and rolled into half circles.

With a boiler built either in full-ring course or in half sheets extending from head to head, the importance of having the plate truly curved to the proper radius cannot be underestimated. If this is not done the continual flexure or bending action, will eventually result in failure at the joint regardless of whether the seam be a butt, strap or lap joint; for the wider the joint then the stiffer it will be. Indeed, we might expect less trouble with a single-riveted lap joint as it would to some extent act as a hinge. Not that I advocate such a joint, but it is mentioned in order to discuss the effects of this flat section.

If we design a boiler 16 feet long to be built in three courses the breaking joints are on opposite sides and we secure the benefit of the girth seams in stiffening the shell, with the weak sections—the horizontal seams—away from each other. Then we have but 16 feet of longitudinal seam whereas with the "one sheet on bottom" boiler we have 32 feet of weak section without any circular seams to support it. Consider the hoops in a barrel as an illustration of the principle applied to a boiler. In the three-course construction the weak sections of the seam are not continuous. In this form of boiler the long seams are placed above the tubes in the steam space where they can be examined both internally and externally.

I believe that beyond question, boilers having one sheet on the bottom are structurally weaker, regardless of rules for determining the safe working pressure, than boilers built in courses. Details may vary with different explosions of boilers built in this manner. In the Canton explosion the rivets sheared, the plate being ⅜ inch and the rivet holes 13/16 inch with a pitch of 3 inches. Other details of the joint were not given. Assuming the usual flexure, it may be that the plate was better or stronger than the shearing resistance offered by the rivets, and the latter received the effects of the bending action.

Looking further into boiler construction, assume a ½-inch plate to be rolled to 72 inches diameter. The outer circumference would be 226.19 inches, the inner 223.05 inches; that is, one side would be 3.14 inches longer than the other. Stresses are thus set up that cannot be determined to a certainty. Some

little is known of the molecular grouping of steel and of the cohesion of the molecules, wherein rests the strength of the plate. When the molecules begin to slip apart and loosen their hold upon one another we say that the limit of elasticity has been reached and we avoid loads that will produce this result. In a 72-inch diameter boiler with ½-inch plates shall we say that the metal at the inner side of the plate has become denser, or what would appear to be more correct, that the cohesion of the molecules at the outer side of the plate has become lessened? It will be noted that this bending action is on a line parallel to the axis of the cylinder and in the path of the horizontal seam. It is usually contended that the factor of safety takes care of these stresses, but we may define this factor of safety as one representing a "factor of ignorance" of something of which we have no correct knowledge.

Looking further into the subject, let us consider the question of punched rivet holes as regards injuring the net section of the plate between the rivet holes and as to whether the joint should be a lapped or a double-butt strap. Specifications calling for the holes to be drilled, or if punched to be reamed out ¼ inch, are ridiculed as old fashioned. English practice as well as United States marine rules recognize the injurious effects of flat punching. W. S. Hutton is authority for the statement that through punching the loss in tenacity is 8, 18 and 26 per cent. for plates ¼, ⅜ and ½ inch, respectively. We need accurate data on the subject but doubtless we shall find that the holes had best be reamed ¼ inch full when assembled.

If one concedes even part of what has been said in this discussion, then the question follows: "What should be done regarding boilers now in operation and constructed with one sheet on the bottom?" May I suggest the value of the hydrostatic test, even granting this may set up strains tending to weaken the boiler? A test applied under the eye of a competent inspector and with the brickwork removed, in order that both seams can be examined, appears to be the best way; and the engineer should afford the necessary facilities for such a test. Also, he may easily provide wooden curves properly supported and struck from a radius, say, 2 inches longer than that of the boiler, and use these to note the proximity to a true circle of the boiler shell both under and without pressure.

The factor of safety for boilers of this type should be greater than for those built in three courses, regardless of rules. This factor should be increased 20 per cent. when the "one sheet on bottom" boiler is 10 years old. In addition I am so convinced of the structural weakness of boilers of this type that I believe no more boilers should be built on these lines and that it is the duty of persons operating or owning such boilers to replace them with new ones designed on better lines.

Doubtless many will say the case has not been proved beyond the point of a doubt. Even so, the fact remains, singular, sinister, and not otherwise explainable, of three disastrous explosions of boilers within a few months built in this manner together with others herein mentioned. Evidence of so strong a nature surely demands consideration.

The annual meetings of the several associations devoted to steam engineering in its various branches will soon take place. In view of the alarming number of boiler explosions would it not be well for them to devote some attention to a consideration of what may be done to assist in preventing further explosions of this kind?

Massachusetts N. A. S. E. Convention

The usual large attendance of delegates and guests assembled at Lowell for the fifteenth annual convention of the Massachusetts State Association of the National Association of Stationary Engineers. The meeting covered a period of three days.

The exhibition of steam and mechanical appliances was opened on Thursday morning, July 7, in Runel's hall, in which the meetings of the convention were also held.

On Friday morning at half past ten o'clock, the convention was formally opened. It was well attended. Past National President Theodore N. Kelsey, chairman of the local committee, called the meeting to order, and after a brief address introduced Mayor John F. Meehan, who welcomed the convention to Lowell. Edward H. Kearney, State deputy, responded fittingly.

Harvey B. Greene, president of the Lowell board of trade, was then introduced and told of the educational advantages of the city. Past State President Fred L. Johnson spoke of the importance of membership in the National Association of Stationary Engineers.

National President William J. Reynolds told of the advantages of State associations, and paid a tribute to Massachusetts as having the best organization.

State President P. E. Tirrell then took the chair, and after appointing the necessary committees, an adjournment was taken until the afternoon at two o'clock.

At the afternoon session considerable important business was transacted. The reading of the reports showed the State association to be in a healthy condition. The election of officers resulted as follows: George L. Finch, president; James H. Sumner, vice-president; Ole B. Petersen, secretary; Walter H. Damon, treasurer; Albert Smith, State deputy. The officers were installed by National President Reynolds. It was voted to hold the next annual meeting at Worcester in July, 1911.

At the close of the session a vote of thanks was given to the Lowell local committee and P. E. Tirrell, the retiring president, was presented a past president's jewel.

One of the main features of entertainment was a smoker at Lincoln hall on Friday evening, at which there were over seven hundred present. The following enjoyable numbers were given: Paragon quartet in vocal selections; Frank J. Corbett, Consolidated Valve Company, songs; John Paine, songs and stories; Frank McCartin, comic songs; Jack Armour, of POWER, monologue and recitals; William Murray, Jenkins Brothers, popular ditties; James E. Donnelly, Scotch songs. The entertainment closed with the singing of "America."

On Wednesday morning the delegates listened to an interesting lecture on "Smoke Prevention," by John S. Schumaker, of Boston. After the lecture, the delegates and visitors boarded a special train for Canobie lake, a beautiful New Hampshire summer resort. The feature of the day was a baseball game between the engineers and supplymen, which was won by the engineers, the score being 8 to 5. There were fully three hundred at the outing. Refreshments were constantly on tap, winding up with an appetizing dinner at three o'clock, after which the return trip to Lowell was made.

During the day suitably inscribed signet rings were presented to Theodore N. Kelsey and Joseph Collins in appreciation of their earnest work in the successful outcome of the convention.

The exhibition was held in a large high ceiling hall, affording ample facilities for the various exhibitors. The booths were erected and decorated by the local association, and everything that could be done for the comfort and convenience of the supplymen was done as only the men in charge of a Massachusetts State convention can do it. Among those who had booths in the exhibit hall were: Albany Lubricating Compound Company; American Oil Company; American Steam Gauge and Valve Manufacturing Company; Ashcroft Manufacturing Company; Ashton Valve Company; Boston Steam Specialty Company; Bundy Department,

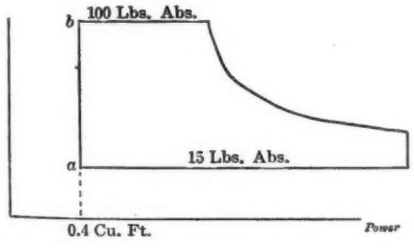
American Radiator Company; Burke Engineering Company; Cancos Manufacturing Company; Challenge Tube Cleaner Company; A. W. Chesterton & Company; Charles A. Claflin Company; Cling-Surface Company; C. B. Coburn Company; Consolidated Safety Valve Company; Crandall Packing Company; Crosby Steam Gage and Valve Company; Paul L. Crowe; M. T. Davidson Company; Dearborn Drug and Chemical Works; Dyna-Como Company; Eagle Oil and Supply Company; Economy Lubricating Company; Enterprise Rubber Company; Evans Mill Supply Company; Federal Metallic Packing Company; France Packing Company; I. A. Fraser; Gardner Grate Company; Garlock Packing Company; Greene, Tweed & Co.; Hancock Inspirator Company; Hart Packing Company; Hayden & Derby Manufacturing Company; Home Rubber Company; Jenkins Brothers; H. W. Johns-Manville Company; Keystone Lubricating Company; George W. Knowlton Rubber Company; Lagonda Manufacturing Company; Lake Erie Boiler Compound Company; Liberty Manufacturing Company; Lloyd Manufacturing Company; Lunkenheimer Company; McLeod & Henry Company; Mason Regulator Company; Mechanical Rubber Company; Monarch Valve and Manufacturing Company; *New England Engineer;* Patterson Lubricating Company; Peerless Rubber Manufacturing Company; Philadelphia Grease Company; POWER; *Practical Engineer;* Quaker City Rubber Company; Revere Rubber Company; Walter G. Ruggles Company; C. E. Squires Company; Strong, Carlisle & Hammond Company; J. H. Williams & Co.; William R. Winn; Herbert W. Yeomans.

A Steam Problem

Try this problem from Professor Spangler's "Notes on Thermodynamics." There is a development in the solution which may surprise you.

We have given:

Initial pressure, 100 pounds absolute; exhaust pressure, 15 pounds absolute;



quality of entering steam, dry saturated; quality of exhaust steam, 0.9; volume of clearance, 0.4 cubic foot. Find the weight of the steam at *b* and its condition, assuming that there is no heat transfer to the cylinder walls.

Boiler Explosion in New Hampshire

Shortly before six o'clock on the afternoon of July 5, a horizontal-tubular boiler of single-riveted lap-seam construction in the Lakeport Steam Laundry, Laconia, N. H., exploded, wrecking the building, killing one person and injuring seven others.

More specific information will be given in a later issue.

PERSONAL

On June 30, James S. Glew resigned his position as general foreman and master mechanic for the Wagner Electric Company, St. Louis, Mo. He will make an extended trip through the West.

His shopmates presented to him a token of their esteem in the form of a watch-charm which bears the emblems of the various Masonic orders of which he is a member.

SOCIETY NOTES

The United Standard Engineers' Mutual Benefit Association will hold its annual outing this year at Queens Avenue hotel and park, Twentieth street and Queens avenue, Flushing, L. I., on Sunday, August 14, 1910.

The eighty-ninth meeting of the National Association of Cotton Manufacturers will be held on September 21 and 22, at the New Mathewson house, Narragansett Pier, R. I.

The several papers, which were either offered too late to find a place on the program at the last meeting, or have been recently offered, are to be presented at this meeting. The secretary desires additional papers from the members.

Further detailed information will be given about September 1, by which time all of the preliminary arrangements will have been completed.

The fourth annual outing and field day of the Engineers' Blue Club, of Jersey City, N. J., was held on Sunday, July 10, at Midland park, Grant City, Staten Island.

At ten o'clock in the morning breakfast was served, after which outdoor sports of all kinds were indulged in, the winner of each race was presented with a valuable prize. The big event of the day was the baseball game between the engineers and the New York "Bunch." The contest ended in a victory for the "Bunch" by the score of 19 to 7. M. V. Ryerson and Herbert Self were the umpires.

Dinner was served at five o'clock, and after the several prizes had been distributed, including three past-president emblems, the company boarded the cars for home, everyone voting the day a very pleasant one.

The committee of arrangements were Martin J. Hickey, William H. Cronley, John H. Foote, Frank A. La Pointe and John Callahan.

NEW PUBLICATIONS

ELECTRIC POWER PLANTS. By T. E. Murray. Published by the author. Cloth; 337 pages, 6x9 inches; 152 illustrations.

This is a series of power-plant descriptions, the subjects being those stations which have been designed by Mr. Murray. They comprise the two "Waterside" stations of the New York Edison Company; the Central (Third Avenue) and Williamsburg (Kent Avenue) stations of the Brooklyn Rapid Transit Company; the Gold street station of the Brooklyn Edison Company; the stations of the Citizens' Light and Power Company, Rochester, N. Y., and the Utica (N. Y.) Gas and Electric Company; the station (hydraulic) of the Chattanooga (Tenn.) Power Company; the power house of the Helderberg Cement Company, and five representative substations in New York City.

The descriptions are very comprehensive and fully illustrated, so that the book is an excellent presentation of the latest engineering practice in power-station design and construction. It is not on sale; copies have been distributed chiefly amongst Mr. Murray's numerous friends and acquaintances in engineering circles.

NEW INVENTIONS

Printed copies of patents are furnished by the Patent Office at 5c. each. Address the Commissioner of Patents, Washington, D. C.

PRIME MOVERS

WIND MOTOR. Thomas H. E. Folger, Corral, Idaho. 961,766.

COMPOUND STEAM ENGINE. Herbert H. Pilcher, Mullins, Tenn. 961,795.

ROTARY ENGINE. Andrew A. Edwards and Adna Olson, Stanwood, Wash. 961,849.

CARBONIC ACID MOTOR. Ludwig Horst, Altona, Germany. 961,859.

EXPLOSION ENGINE. Pierre Alexandre Darracq, Suresnes, France, assignor to Societe A. Darracq & Cie. (1905), Limited, Suresnes, France. 961,938.

EXPLOSIVE DRIVEN ENGINE. Albert A. Jahnke, Oakland, Cal. 961,966.

ROTARY EXPLOSIVE ENGINE. Elmer A. Thomas and William V. Ritter, St. Louis, Mo. 962,064.

TURBINE. Birger Ljungstrom, Stockholm, Sweden. 962,088.

INTERNAL COMBUSTION ENGINE. Geo. John Altham, Fall River, Mass. 962,110.

INTERNAL COMBUSTION ENGINE. Frederick E. Dayes, Brooklyn, N. Y. 962,131.

COMPOUND REVERSIBLE ROTARY ENGINE. Hermand Eriksen, Philadelphia, Penn. 962,204.

AIR-COOLED ENGINE. William J. Miller, Springfield, Ohio, assignor, by mesne assignments, to the Kelly Motor Truck Company, Springfield, Ohio, a Corporation of Ohio. 962,233.

MOTOR. Albert F. Rockwell, Bristol, Conn., assignor to the New Departure Manufacturing Company, Bristol, Conn., a Corporation of Connecticut. 962,254.

WATER TURBINE. Thomas B. Lee, Charlotte, N. C. 962,364.

HYDRAULIC WATER MOTOR. Lemon I. Osborn, Portland, Ore. 962,382.

BOILERS, FURNACES AND BURNERS

CRUDE-OIL BURNER. Rufus C. Reed, Jacksonville, Tex., assignor of one-half to W. A. Day, M. W. Totty, and R. D. Atkinson, Jacksonville, Tex. 961,797.

COMBINED GAS- AND SMOKE-CONSUMING ATTACHMENT. Frank Shmonsky, Ridgway, Penn. 961,810.

OIL BURNER. Henry R. Green, Spokane, Wash. 962,212.

OIL BURNER. William C. Blackmond, Tomball, and Guy Everett Stoy, Teague, Tex. 962,301.

STOKER MECHANISM. Paul L. Crowe, Jersey City, N. J. 962,322.

WATER-TUBE BOILER. Signono C. Munoz, Montclair, N. J., assignor to the Babcock & Wilcox Company, New York, N. Y., a Corporation of New Jersey. 962,454.

BURNER FOR LIQUID FUEL. Frank S. McKibben, Memphis, Neb. 962,457.

CONSTRUCTION OF MOTIVE FLUID GENERATORS. Frank S. McKibben, Memphis, Neb. 962,457.

CONSTRUCTION OF MOTIVE FLUID GENERATORS. Frank S. McKibben, Memphis, Neb. 962,458.

GASEOUS FUEL BURNER. Henry Schneider and Clarence Schneider, Lima, Ohio. 962,472.

VAPORIZER FOR GAS PRODUCERS. Baxter M. Aslakson, Salem, Ohio. 962,610.

CONSTANT SUPPLY DEVICE FOR VAPORIZING FUEL GAS MACHINES. John F. Barker, Jr., Boston, Mass., assignor to Gilbert & Barker Manufacturing Company, Springfield, Mass., a Corporation. 962,611.

OIL BURNER. Roland C. Casad, Covina, Cal. 962,695.

GRATE BAR. Anderson Wilderspin, Grand Saline, Tex., assignor of one-half to David C. Earnest, Dallas, Tex. 962,805.

BURNER. George J. McPherson, Salt Lake City, Utah, assignor, by direct and mesne assignments, to International Oil Gas Producer Company, a Corporation of Utah. 962,971.

HYDROCARBON BURNER. Ira L. Owens, Effingham, Kan. 963,010.

POWER PLANT AUXILIARIES AND APPLIANCES

CONDENSER. George M. Harden, Philadelphia, Penn., assignor to the Philadelphia Pipe Bending Company, a Corporation of New Jersey. 962,427.

PROCESS OF REMOVING SCALE FROM PIPE. Herluf A. F. Petersen, Chicago, Ill., assignor to J. H. W. Petersen, Chicago, Ill. 962,462.

PUMP. James E. Naughtin, Chicago, Ill. 962,518.

RELIEF DEVICE. Rudolph Conrader, Erie, Penn. 962,551.

BELT. Jackson W. Foster and Albert A. Stoddard, Jacksonville, Fla. 962,563.

PLUNGER PACKING FOR ELEVATORS. James C. Phelps, Springfield, Mass. 962,585.

PISTON RING. Justen Stoddard, Stillwater, Minn. 962,599.

SPARK PLUG. Gregor Walzel, New York, N. Y. 962,604.

CARBURETER. Harry A. Miller, Los Angeles, Cal. 962,649.

STARTING APPARATUS FOR GASOLENE ENGINES. Vaughan Morrill, Tacoma, Wash. 962,653.

VALVE. James G. Nolen, Chicago, Ill., assignor, by mesne assignments, to Automatic Fire Protection Company, a Corporation of Maine. 962,660.

WATER-FEED REGULATOR. Walter H. Bice, Maple Lodge, Ontario, Canada, assignor of one-half to Alfred Westman, and one-sixth to William R. Colby, London, Canada. 962,735.

PUMP GOVERNOR. Walter H. Bice, Maple Lodge, Ontario, Canada, assignor of one-half to Alfred Westman and one-sixth to William R. Colby, London, Canada. 962,736.

AUTOMATIC PRESSURE-REDUCTION VALVE. Walter H. Bice, Maple Lodge, Ontario, Canada, assignor of one-third to Alfred Westman and one-sixth to William R. Colby, London, Ontario, Canada. 962,737.

VALVE. Edward A. Lacy and Fred C. Williams, Galeton, Penn. 962,766.

FLEXIBLE CONDUIT. George A. Lutz, Plainfield, N. J., assignor to American Circular Loom Company, Portland, Me., a Corporation of Maine. 962,772.

HOISTING MECHANISM. George W. Murray, Chicago, Ill. 962,779.

STEAM CONDENSER. Preston H. Sellers, East St. Louis, Ill. 962,789.

PACKING RING. Curtis E. Drown, Tucson, Ariz. 962,820.

LUBRICATING APPARATUS FOR STEAM ENGINES. Edward Ryan, Clinton, Iowa. 962,859.

CARBURETER. Stephen P. Sanders, Cupertino, Cal. 962,860.

STEAM PUMP. John March, Dillon, Mont. 962,906.

WATER-FEED REGULATOR. Walter H. Bice, Maple Lodge, Ontario, Canada, assignor of one-sixth to William R. Colby, and one-half to Alfred Westman, London, Canada. 963,019.

GOVERNOR. Frank L. Nichols, Stamford, Conn., assignor to Nichols Quadruple-Traction Vehicle & Power Company, Stamford, Conn., a Corporation of New York. 962,163.

JOURNAL-BOX BRASS. John M. Rohlfing, St. Louis, Mo., assignor of one-half to Robert E. Frame, St. Louis, Mo. 962,166.

CENTRIFUGAL-OILING BEARING. Frederick A. Warren, Canon City, Colo. 962,182.

CRANK CONNECTION FOR MULTI-CYLINDER ENGINES. Frank A. Edmunds and Niels G. Warming, St. Paul, Minn. 962,200.

VALVE-CONTROL MECHANISM FOR EXPLOSION ENGINES. Norman T. Harrington, Lansing, Mich. 962,214.

MECHANISM FOR FEEDING FUEL. Albert F. Rockwell, Bristol, Conn., assignor to the New Departure Manufacturing Company, Bristol, Conn., a Corporation of Connecticut. 962,248.

COOLING MEANS FOR MOTORS. Albert F. Rockwell, Bristol, Conn., assignor to the New Departure Manufacturing Company, Bristol, Conn., a Corporation of Connecticut. 962,249.

PUMP. Albert F. Rockwell, Bristol, Conn., assignor to the New Departure Manufacturing Company, Bristol, Conn., a Corporation of Connecticut. 962,251.

SPARKING APPARATUS. Albert F. Rockwell, Bristol, Conn., assignor to the New Departure Manufacturing Company, Bristol, Conn., a Corporation of Connecticut. 962,255.

VALVE. Thomas Pittinger Long, Barberton, Ohio, assignor of one-half to Willard M. Huffman, Barberton, Ohio. 962,368.

VALVE GEAR FOR FLUID-PRESSURE ENGINES. James Thompson Marshall, Leeds, England. 962,374.

ELECTRICAL INVENTIONS AND APPLICATIONS

ELECTROMAGNET. Campbell Scott, Yonkers, N. Y., assignor to Otis Elevator Company, Jersey City, N. J., a Corporation of New Jersey. 961,805.

RECHARGEABLE ELECTRIC FUSE. Agostine J. Orelli, Longbeach, Cal. 961,891.

CIRCUIT INTERRUPTER FOR ELECTRIC SPARKING DEVICES. James E. Seeley, Los Angeles, Cal., assignor to High Frequency Ignition Coil Company, Los Angeles, Cal., a Corporation of California. 961,902.

ELECTRIC WATER HEATER. William F. Cutler, San Francisco, Cal., assignor to Cutler National Electric Heater Company, San Francisco, Cal., a Corporation of California. 961,937.

CIRCUIT CONTROLLER. Fred I. Getty, Jennings, La., assignor to Charles F. Gillmann, New York, N. Y. 961,951.

ELECTRICAL CONDENSER. Ray H. Manson, Elyria, Ohio, assignor to the Dean Electric Company, Elyria, Ohio, a Corporation of Ohio. 961,978.

RECEIVER FOR ELECTRIC SIGNALING. Reginald A. Fessenden, Washington, D. C., assignor to the National Electric Signaling Company, a Corporation of New Jersey. 962,015.

RECEIVER FOR ELECTROMAGNETIC WAVES. Reginald A. Fessenden, Washington, D. C. 962,016.

ALTERNATE-CURRENT COMMUTATOR MOTOR. Rudolf Richter, Charlottenburg, Germany, assignor to Siemens-Schuckertwerke G. M. B. H., Berlin, Germany, a German Corporation. 962,101.

ELECTRICITY METER. Dugald C. Jackson, Madison, Wis., assignor to Dugald C. Jackson and William B. Jackson, Madison, Wis., a Copartnership. 962,222.

ELECTRIC TIME SWITCH. Carey E. Bunker, Oregon, Mo. 962,307.

ALTERNATING-CURRENT MOTOR. Valere Alfred Fynn, London, England. 962,335.

POWER PLANT TOOLS

WRENCH. Robert H. Peters, Buffalo, N. Y. 961,894.

WRENCH. William B. Brown, Pittsburg, Penn. 962,304.

PIPE WRENCH. Alexander Kondas and Paul Bajusz, Woodriver, Ill. 962,359.

ENGINEERING SOCIETIES

AMERICAN SOCIETY OF MECHANICAL ENGINEERS

Pres., George Westinghouse; sec., Calvin W. Rice, Engineering Societies building, 29 West 39th St., New York. Monthly meetings in New York City.

NATIONAL ELECTRIC LIGHT ASSOCIATION

Pres., W. W. Freeman, Brooklyn, N. Y.; sec., T. C. Martin, 33 West Thirty-ninth St., New York.

AMERICAN SOCIETY OF NAVAL ENGINEERS

Pres., Engineer-in-Chief Hutch I. Cone, U. S. N.; sec. and treas., Lieutenant Henry C. Dinger, U. S. N., Bureau of Steam Engineering, Navy Department, Washington, D. C.

AMERICAN BOILER MANUFACTURERS' ASSOCIATION

Pres., E. D. Meier, 11 Broadway, New York; sec., J. D. Farasey, cor. 37th St. and Erie Railway, Cleveland, O.

WESTERN SOCIETY OF ENGINEERS

Pres., J. W. Alvord; sec., J. H. Warder, 1735 Monadnock Block, Chicago, Ill.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA

Pres., E. K. Morse; sec., E. K. Hiles, Oliver building, Pittsburg, Penn. Meetings 1st and 3d Tuesdays.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

Pres., L. B. Stillwell; sec., Ralph W. Pope, 33 W. Thirty-ninth St., New York. Meetings monthly, excepting July and August.

AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS.

Pres., Prof. J. D. Hoffman; sec., William M. Mackay, P. O. Box 1818, New York City.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS

Pres., William J. Reynolds, Hoboken, N. J.; sec., F. W. Raven, 325 Dearborn street, Chicago, Ill. Next convention, Rochester, N. Y., September, 1910.

UNIVERSAL CRAFTSMEN COUNCIL OF ENGINEERS

Grand Worthy Chief, W. S. Cadwell, Chicago, Ill.; sec., Thomas H. Jones, 244 Eighth street, N. E., Washington, D. C. Next convention, Buffalo, N. Y., August 2-5, 1910.

AMERICAN ORDER OF STEAM ENGINEERS

Supr. Chief Engr., Frederick Markoe, Philadelphia, Pa.; Supr. Cor. Engr., William S. Wetzler, 753 N. Forty-fourth St., Philadelphia, Pa. Next meeting at Philadelphia, June, 1911.

NATIONAL MARINE ENGINEERS BENEFICIAL ASSOCIATIONS.

Pres., William F. Yates, New York, N. Y.; sec., George A. Grubb, 1040 Dakin street, Chicago, Ill. Next meeting, St. Louis, Mo., January 16-21, 1911.

OHIO SOCIETY OF MECHANICAL ELECTRICAL AND STEAM ENGINEERS

Pres., O. F. Rabbe; sec. and treas., Prof. F. E. Sanborn, Ohio State University, Columbus, Ohio.

INTERNATIONAL MASTER BOILER MAKERS' ASSOCIATION

Pres., A. N. Lucas; sec., Harry D. Vaught, 95 Liberty street, New York. Next meeting at Omaha, Neb., May, 1911.

INTERNATIONAL UNION OF STEAM ENGINEERS

Pres., Matt. Comerford; sec., Robert A. McKee, 606 Main St., Peoria, Ill. Next convention, Denver, Colo., September, 1910.

NATIONAL DISTRICT HEATING ASSOCIATION.

Pres., G. W. Wright, Baltimore, Md.; sec. and treas., D. L. Gaskill, Greenville, O.